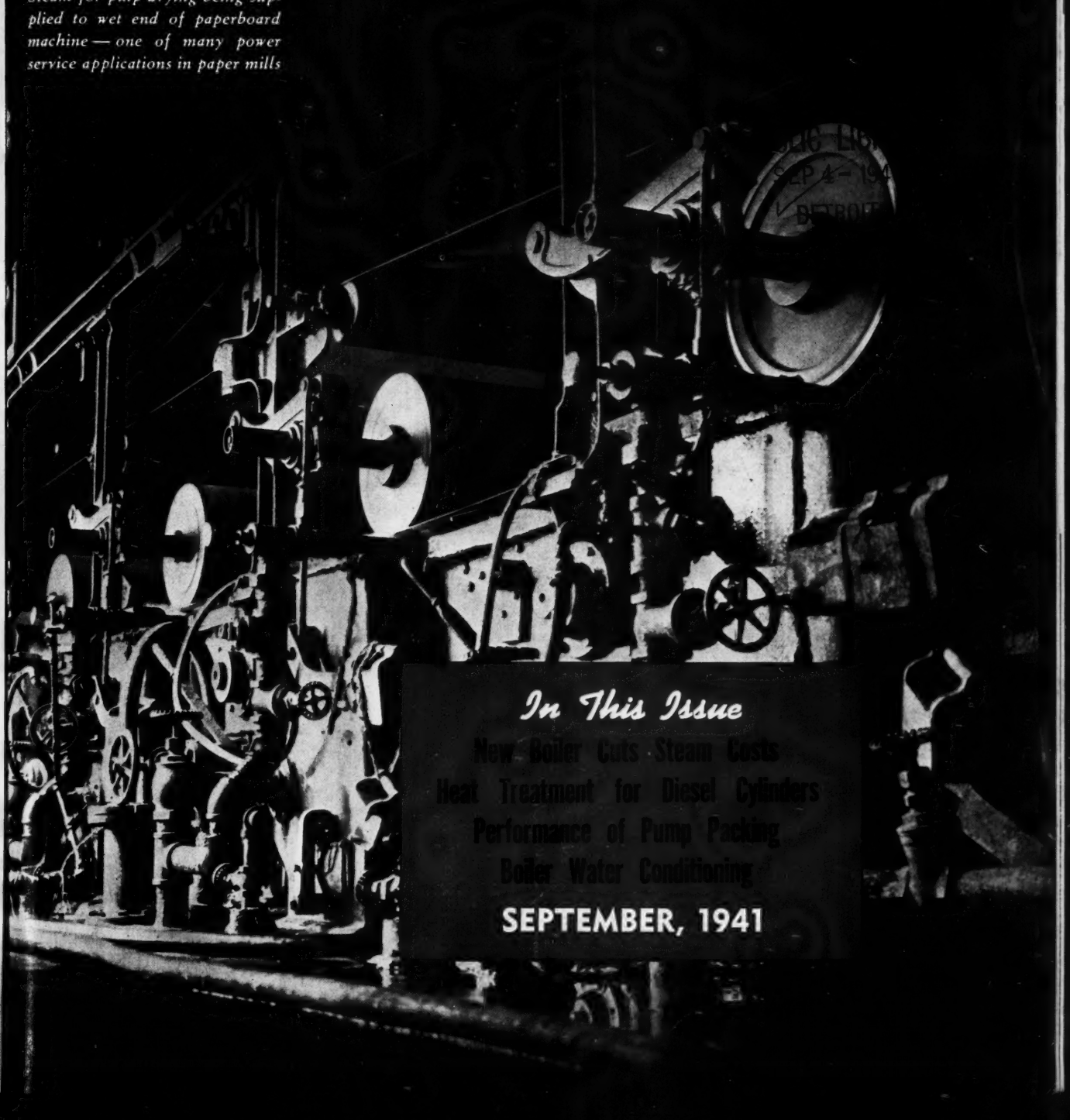
POWER PLANT ENGINEERING

THE PLANT ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

Steam for pulp-drying being supplied to wet end of paperboard machine — one of many power service applications in paper mills



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New Boiler Cuts Steam Costs

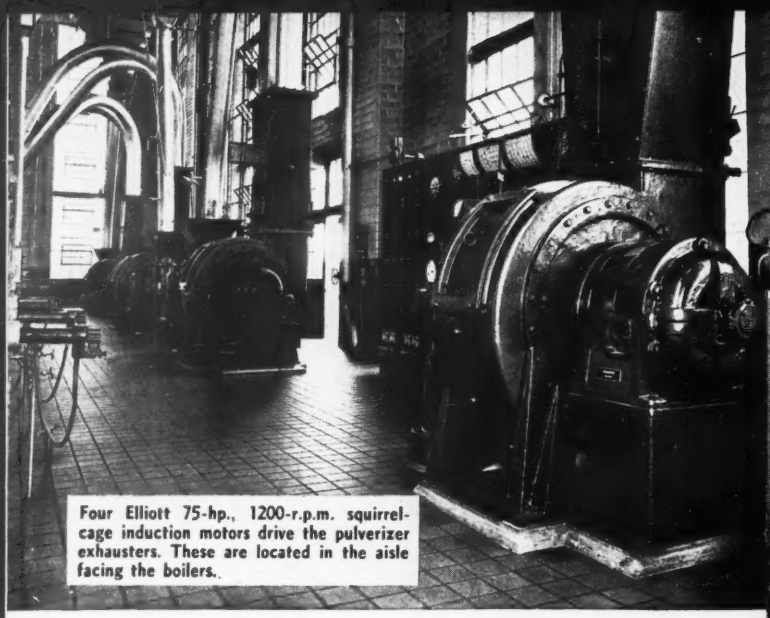
Heat Treatment for Diesel Cylinders

Performance of Pump Packing

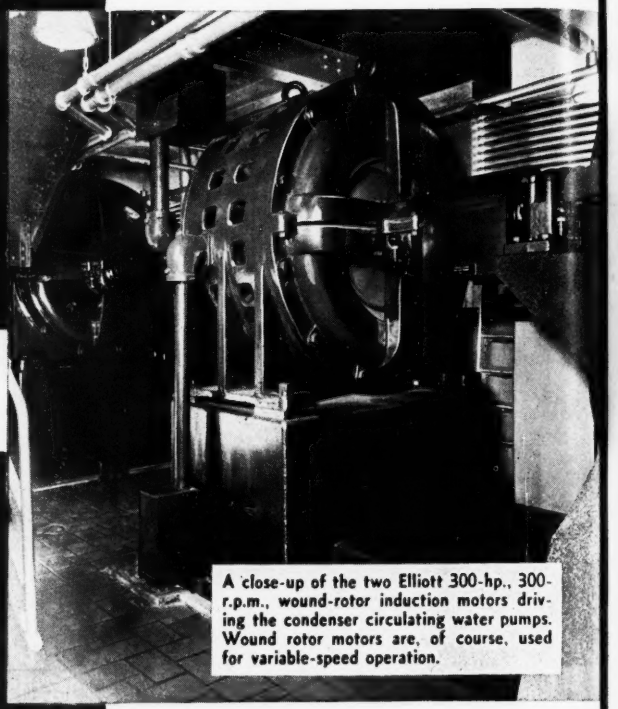
Boiler Water Conditioning

SEPTEMBER, 1941

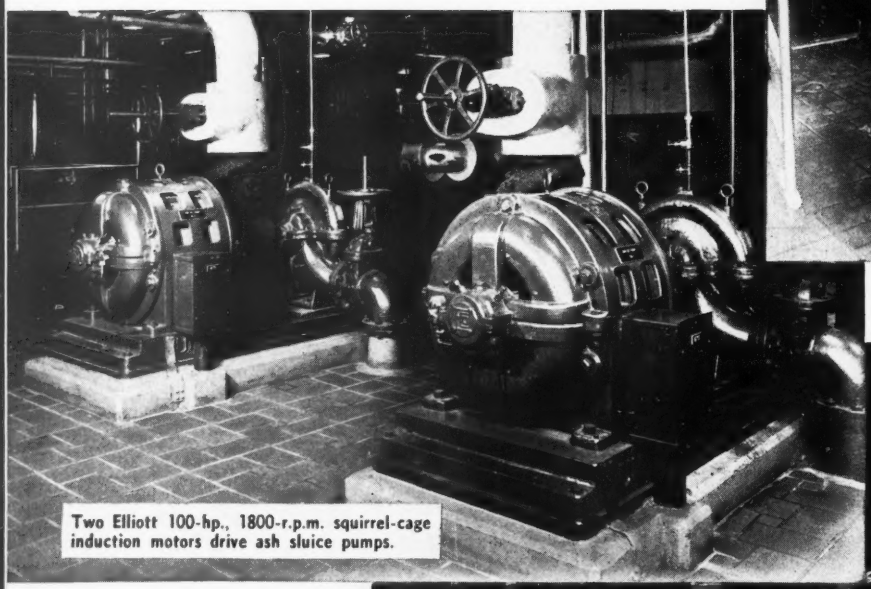
IT IS



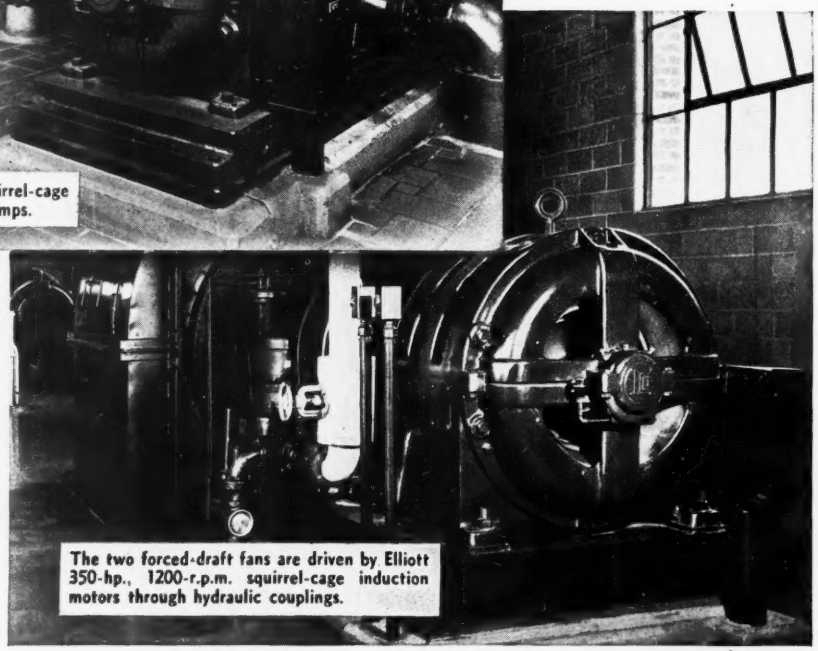
Four Elliott 75-hp., 1200-r.p.m. squirrel-cage induction motors drive the pulverizer exhausters. These are located in the aisle facing the boilers.



A close-up of the two Elliott 300-hp., 300-r.p.m., wound-rotor induction motors driving the condenser circulating water pumps. Wound rotor motors are, of course, used for variable-speed operation.



Two Elliott 100-hp., 1800-r.p.m. squirrel-cage induction motors drive ash sluice pumps.



The two forced-draft fans are driven by Elliott 350-hp., 1200-r.p.m. squirrel-cage induction motors through hydraulic couplings.

The photos on these pages are typical. All were made in the Bryce E. Morrow Station of Consumers Power Company, where twenty Elliott motors of from 75 to 800 hp. drive essential auxiliaries.

ELLIOTT COMPANY

POWER PLANT ENGINEERING

SEPTEMBER, 1941
VOLUME 45, No. 9

Cover: A wet end of a paperboard machine is one through which the refined pulp passes in the first steps of matting the pulp particles together in a solid sheet. Large felt belts are the carrying medium. These belts pass between a series of heavy rollers which further press the moisture from the sheet.

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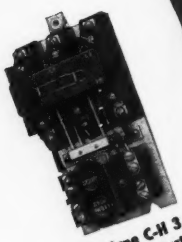

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THE VOICE OF INDUSTRY

J. EDGAR HOOVER on COURAGE and the FIGHT for DEMOCRACY

THE WORLD is desperately in need of young men with courage and character for today Democracies are on trial. Our form of government is challenged throughout a large part of the earth by other essentially different and to us basically hateful systems, based upon the nefarious assumption of power to strangle the personal initiative, rights and freedom of the people in the priceless pursuit of the democratic way of life.

There is only one way in which democracy can answer dictatorship; that is by the proof that it is a more livable, a more intelligently human and a more humane form of government. To do this, it must be of the form which was given into the keeping of America by our forefathers; an athletic type of democracy, if I may so describe it, alert to every possible danger, yet never aggressive; quick on defense of our rights, yet never the bully or the braggart. This was the human, humble, virile, yet militantly protective democracy which grew and flourished so effectively until nearly a generation ago.

Then, did we grow too rich? Did we grow too tired? Did we become too lazy? Did we become dissatisfied with too much of plenty? Or did we forget those God-given qualities of sureness, of strength, of courage, and of vigilance which had made the eagle a symbol of this nation, and its sharpness of eye and smoothness of speed symbolical of the swiftness and unity with which we met and defeated an alien effort against our heritages?

Whatever it was, the change which came over us was fundamentally dangerous. At heart a law-abiding people, we became so lethargic, so apathetic to the encroachments of the underworld, that we permitted to grow within our boundaries a veritable army of criminally inclined men and women. . . . With our minds engrossed in materialistic and selfish pursuits, we have allowed thousands of espousers of alien hate and foreign isms to enter our communities, our neighborhoods, our factories, our stores, our homes, and even our governmental agencies. . .

That word "liberalism" is something we should weigh carefully during these dark days that confront our nation. There is nothing more cowardly than a criminal . . . pretending respectability while practicing the vilest of crimes. Is there not a strange connection between such persons and certain apostles of degenerate dictatorships . . . who advance upon us in sham cloaks of liberalism, pretending to be seeking social reforms and equality for all, while in reality plotting to trample beneath their blood-stained boots the very document which has been their greatest protection, our sacred Constitution of the United States!

In the vaunted peacefulness of our homeland, espousers of foreign hates have stalked at will. These sinister enemies of America seek to destroy the faith of our youth in democracy. They use easy promises to lure them into blind acceptance of the venal doctrines of gangster governments. "This is the new order," they counsel. I challenge that contention. It is neither new nor does it bear any semblance to order. Right-thinking people recognize it as a barbaric throwback to the jungle law of kill and plunder and might makes right . . .

We must awaken! We must again be young in mind, in heart and in our love and fealty to America. We must be interested in preserving the soul of America. We must make our nation again worthy to have the eagle as its emblem, not only of power, but of swiftness of action and of protective preparedness. We must again become virile and strong. We must retrain ourselves to once more be the athletic nation, both in mind and body, which we believed ourselves to be. It can be done and it will be done. . .

That is our duty and we must not fail in its fulfilment if our free and unfettered way of life is to continue its uninterrupted course under a Constitution created by free men. Let that eternal triad of our United States, forever be before us —love of God, love of liberty and love of country.

J. EDGAR HOOVER, the Nation's No. 1 G-man, is officially director of the Federal Bureau of Investigation, U. S. Department of Justice, a post he has held since 1924. He was born in the District of Columbia in 1895 and joined the Department of Justice in 1917.

A graduate of George Washington University with both a bachelor's and master's law degree, he: holds honorary degrees from six other colleges; has been admitted to the bar in the District of Columbia Supreme Court, the U. S. Court of Claims and the U. S. Supreme Court; is a Lieutenant Colonel in the Military Intelligence Div. of the U. S. Army Officers Reserve Corps; and has received national and international recognition of his activities in promoting police collaboration, for crime prevention and for distinguished public service.

The paragraphs on this page were taken from an address he delivered at the Commencement Exercises of the University of the South, Sewanee, Tenn., on June 9. It is more than a message to youth—it is a warning to all America that democracy, under which our industry grew and prospered, will wither and die under apathetic tolerance and can thrive only with constant virilent support.

Photo, Portland Electric Co.

MT. OSBORNE CLIMBED

MOUNTAINEERS throughout the world were startled during the early part of July by news of a mass assault on Mt. Osborne in the Pacific Northwest by a group of members of the Oregon Trails Club. For the first time in the history of mountaineering, a group of mountaineers, as such, successfully scaled a wooden mountain. Of course, the sawdust pile had been climbed many times before by the crew who keep it piled up, but their ascents never got into the newspapers. When a roustabout climbs a pile of sawdust in order to hook a cable to a drag scraper, nobody thinks very much about it—it's just routine—but when a group of bona fide mountaineers struggle up the same heap of sawdust for no reason at all, that's news. ¶ Mt. Osborne, by way of explanation is the worlds largest and highest sawdust pile. It adjoins Portland General Electric Company's Station "L" steam plant in Portland, Ore. and is named after the company's general superintendent, C. P. Osborne. The sawdust (or "hog fuel") has been piled up to help stave off a power shortage in the Portland area. Stream levels are so low that hydro plants will fall short of meeting anticipated power demands. The pile covers 4 acres and contains 10,450,000 cu. ft. of sawdust, enough fuel to run Station "L" for 30 days if it burned sawdust exclusively. Normally it burns oil as well. While the company has maintained a large sawdust pile at this plant for many years, it has been growing considerably lately and it has now reached a height of 130 ft. Such mountainious proportions could not fail to attract the attention of any true mountaineer and so it was that on July 9 a group of climbers of the Oregon Trails Club made a successful ascent of the peak. It is reported that all returned with sawdust in their shoes. Station "L", by the way, is the world's largest woodburning power plant.

WITH THE EDITORS

◆ **PATRIOTISM AND/OR PROFIT?** . . . For years engineers have conceded that in factories, office buildings and institutions of small and medium size, where exhaust steam from electric generating units cannot all be used for heating or process work, it is frequently more economical to purchase electric power than to provide and operate generating equipment. Each case, of course, needs separate consideration, for there are many schemes which engineers have devised for utilizing by-product heat. Today, however, another factor other than pure engineering economics enters the problem and that is whether or not the local utility has the capacity to carry the industrial load without inconvenience to important users of power for defense purposes.

One case came to our attention recently where a hotel in the T.V.A. district is installing electric generating equipment in order to relieve the load on the utility system which had been forced to put restrictions on customers using the service. The hotel manager stated that he considered it a patriotic duty to relieve the overload on the utility in order to give more power for the production of war materials. More than likely he will find it a profitable investment for there are many uses for exhaust steam around hotels.

◆ **INDUSTRIALS DEPENDING ON UTILITIES** . . . Throughout the country generally, electric utilities are not requesting customers to curtail their use of power, but for their own good power users should not be wasteful. Human habits are difficult to change and under the conditions prevailing during the past decade many people have become careless, even wasteful, in their use of electricity. Electric rates have been continuously decreasing and each year has brought forth many new electrical appliances and processes that have resulted in an all-time high consumption of electric power.

Some industrial plants, handicapped because of inadequate power generating capacity, turned immediately to the purchase of power when their power loads began to tax the capacity of their own plants and are not planning extensions to their generating equipment due to the prevailing thought that the present business activity will be short lived and their investment in power equipment would result in idle machinery within a relatively short time.

The fact is, many of these plants have allowed their power generating facilities to become worn out, obsolete and in bad repair to such an extent that the capacity has actually decreased and they will not even carry what they formerly considered a normal load. In some plants where connection is not made with the utility system, engineers are having difficulty in meeting the power demand. For those serving essential defense industries, new power equipment may be had when manufacturers are able to make deliveries, other plants, handicapped by priority rulings at the present time, out of sheer necessity, are resorting to every known device for increasing capacity and holding the load to the necessary minimum.

◆ **HISTORY REPEATS** . . . This same situation, with some modification, existed during World War I and many plants were built according to designs that were old or not carefully considered for the particular service they were to perform which resulted in inefficiency and rapid obsolescence. Many of these, inadequate as they were even when new, are still being depended upon to serve their factories. At that time many startling conditions were discovered by the Fuel Administration and some plants were not even permitted to operate because of inefficiency in converting fuel into power.

The engineer confronted with an overload on his plant will do well to make a survey of his entire power generating equipment from coal pile to bus bars. Then step over into the factory and study the uses of the services the power plant renders. Efficiency of power generation demands attention to all details and a survey should indicate not only the condition of the equipment and how it can be repaired or improved, but whether or not the operators are carrying out instructions in a satisfactory manner. Changing firing equipment, giving more attention to boiler water treatment, increasing the draft, replacing manual with automatic combustion control are just a few of many measures taken which have eased the overload situation for many engineers.

In the factory or wherever services are used, some precautions to be taken are: Eliminate operation of motors when machines are idle; group machines so that driving motors or engines operate at their highest efficiency; see that all bearings are regularly oiled and inspected to correct alinement and insure operation with least friction; eliminate belt slippage, so far as possible; stagger manufacturing operations so that peak loads will be more evenly distributed; provide means for obtaining high power factor; reduce elevator and hot water services to a minimum; stop all leaks in water spigots, piping, etc.; turn out lights when not in actual use; use most efficient type of lamps; provide thermometers in all locations where heat is supplied and arrange to keep temperature within reasonable limits; provide adequate building insulation. Such precautions have been notably effective in reducing power plant loads.

◆ **EXPANSION PLANNED** . . . While consumers are endeavoring to economize on power from utility stations, utility companies are making plans to meet the loads as nearly as they can be predicted. A program of construction has been worked out by Leland Olds, Chairman of the Federal Power Commission, following a series of conferences with representatives of the major public and private utility systems. The plan is based on the necessity of preparing for defense expenditures which, according to estimates, will be running at $3,000,000,000 per month by 1943. Translated into power, this means a defense load of approximately 20,000,000-kw.

Construction is being planned 5 yr. ahead and funds are expected to be secured through the Reconstruction Finance Corporation as well as private sources. Costs are estimated at from $150,000,000 to $200,000,000 a year and the investment would be self-liquidating.

If such a program is carried out, the country should have no fear of a power shortage, for this additional capacity would greatly exceed the rise in load reported during the last year, a period in which the factories working on defense products have been expanding their output to the limit. With proper co-ordination, power capacity can be added as rapidly as new factories can be built and equipped for manufacturing. And with the Government committed to the program, priority rights will assist in meeting the construction schedule.

Further Improvements To

Fig. 1. A general view in the turbine room showing the new unit with the new switchgear at the far end of the room

INDUSTRY AND AGRICULTURE, commercial and home life, urban growth and increased rural usage have all contributed to the maintenance of McPherson's high rate of load growth. Never an acute sufferer from the effects of the depression, this Kansas city is today a thriving center of varied activities. Its activities are directly reflected in the nature and extent of improvements to its municipally owned power plant. Economy is abreast of improvements to capacity.

This south central Kansas city serves as a regional focal point for the expansive wheat growing and processing industries, the oil producing and refining industries, and to a lesser extent for commercial ventures in natural gas, pipe lines, tank trucking, and dairy products. With such varied lines of commerce it withstood surprisingly well the effects of the depression years. With the assistance of wise management, the power plant's gross generation never failed to increase during those years. The lowest per cent annual increase was 5.83 per cent (1931) and the maximum was 54.4 per cent in 1933.

Specific factors influencing this load growth stem from the above mentioned diversified regional and local commercial activities. In the late '20s the rural demand for electricity resulted in a consistent extension of facilities. This activity reached its crest in 1937, when over one hundred miles of rural lines were added to the existing lines serving the southern part of McPherson County. In 1938 the City of Moundridge and the Moundridge Mill (flour) were added to the system, following by several years the earlier acquisition of the load at Galva. Also included among the larger consumers are two prosperous grain elevators and flour mills in McPherson.

The oil industry has played an important role in load growth. Producing wells lie east and northeast of the city and a newer pool lies southwest almost to the county line. Of long life, these wells require pumping in many cases. Two refineries are located close to the city limits. Supplied by the municipal plant since about 1932, their load is both desirable and increasing. One refinery is now constructing a 275 mi. gasoline pipe line with an electrified pumping station.

Table I shows the annual generation, demand, and load factor as well as per cent annual increase for the years 1928 through 1940. Figure 3 shows the monthly generation for the past several years.

It is obvious that this record of growth has occasioned considerable study with appreciation of the underlying factors. Proper

The McPherson, Kansas, Municipal Power Plant

Municipally owned power plant in south central Kansas has shown a steady increase in load over a period of 10 yr. New improvements made at a cost of $337,561 now bring the plant to a total capacity of 10,750-kw. New 5000-kw. turbo-generating unit installed in 1940

BY A. C. KIRKWOOD
Assoc. Engineer, Burns & McDonnell Engineering Co.
Kansas City, Mo.

anticipation of capacity requirements has been made but it must be admitted that the frequent installations of new equipment have not been accomplished without criticism from the owner-consumers. Like the much quoted pudding, the proof is in the eating, use of the new equipment has in each case more than justified its installation.

At the turn of the last decade the plant contained three turbo-generators—500-kw., 750-kw., and 2000-kw., with a firm capacity of 1250-kw. In 1935 a 3000-kw. unit was added and the 500-kw. unit sold; the firm capacity being increased thereby to 2750-kw. Further load growth resulted in the initiation of another improvement program in 1939. The new 5000-kw. turbo-generator was placed in operation in late 1940 with final tests and acceptance made in April, 1941. The plant capacity is now 10,750-kw., the firm capacity being 5750-kw.

The boiler room has required similar improvements. The three existing units have capacities of approximately 29,500, 29,800 and 50,000 lb. per hr. They were installed in 1930, 1932, and 1938. With an anticipated maximum steam demand of approximately 38,000 lb. per hr. in 1941 it is seen that further boiler room improvements will not be required for several years.

The 1935 turbine room improvements included not only turbine, condenser, cooling tower, and new heat balance equipment, but also a major operation on the turbine room itself. The original structure was a low ceiling affair with monorail hoists serving the turbines. During construction, the existing equipment was boxed in with a tar paper sheathed wooden structure, the old building was removed, part of the building foundations were underpinned, and a new, modern turbine room constructed around the existing equipment. Included at the west end of the new structure were space and foundations by the 3000-kw. turbo-generator. Provision was made for extension to the east for future units. A single motored 25 ton crane was installed.

The 1939-40 improvements were in accordance with the previously determined installation plan. The building was extended two panels which, with the space formerly occupied by the 500-kw. unit, was adequate for the new 5000-kw. unit. At the same time the space now occupied by the 750 and 2000-kw. units will be adequate for machines up to 10,000 to 15,000-kw. rating. The photograph, Fig. 1, shows the new unit in the background with the new switchgear nearby.

Conforming to previously determined steam conditions, the new unit is designed to operate at 390 lb. per sq. in., 675 deg. F. total

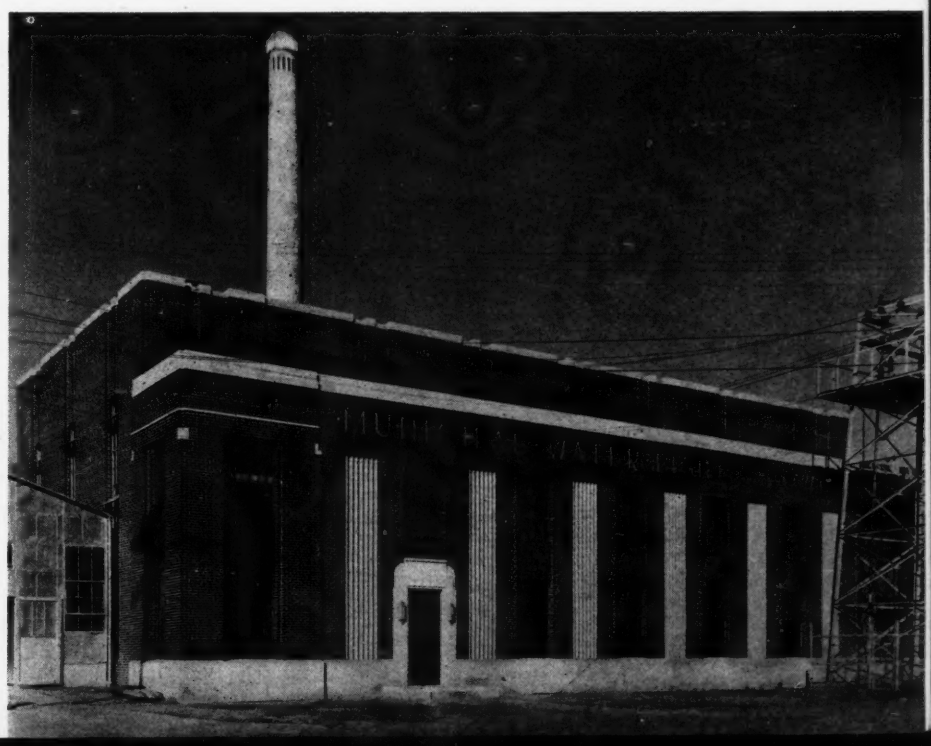


Fig. 2. Exterior. The building was extended two panels to provide room for the new 5000-kw. unit

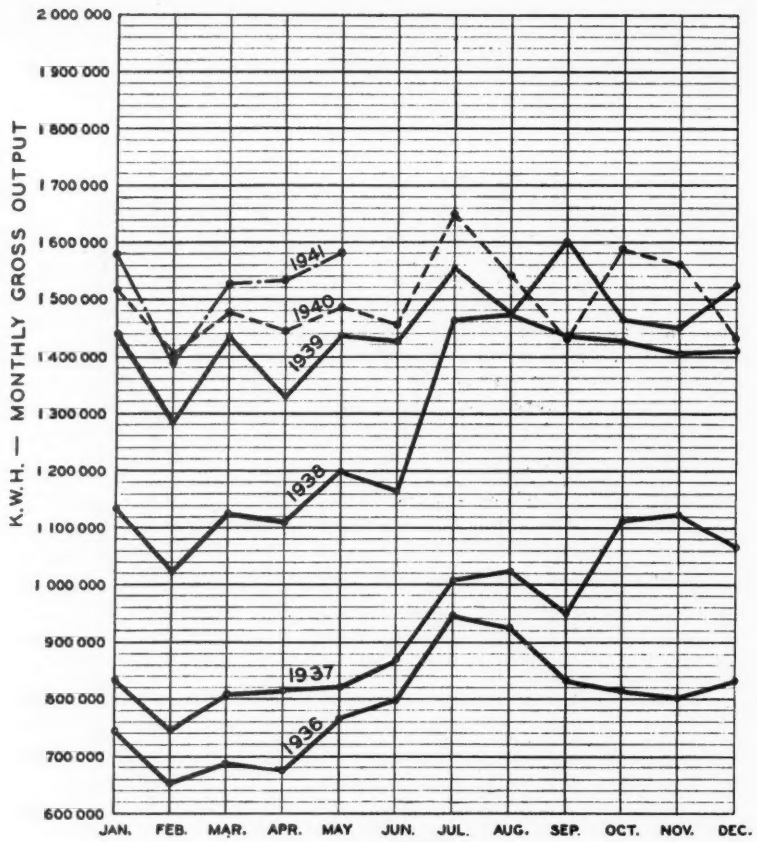


Fig. 3. Monthly generation, 1936 to 1941

temperature. It is a 5000-kw., 80 per cent p.f., 3600 r.p.m. machine. Steam is bled at the 3rd, 4th, and 9th stages for feedwater heating and evaporation of make-up. Designed exhaust conditions are 28 in. Hg referred. At the request of the manufacturer the entire unit, except the turbine exhaust casing and generator and exciter end bells, is finished with stainless steel sheets and strips. The exciter is totally enclosed and is cooled by the generator cooling system. A filter removes exciter carbon brush dust. Voltages are 4100 wye for the generator and 250 for the exciter. The neutral is grounded with a disconnecting switch used to maintain proper electrical circuit conditions.

Serving the turbine is a 7500 sq. ft. two pass, divided water box condenser employing $\frac{7}{8}$ in. by 17 ft. Admiralty metal tubes. Since circulating water temperatures are dependent upon the atmospheric wet bulb temperatures and since air cooling and ventilation are helping to create annual peaks in summer, the condenser was liberally proportioned. It is served by two 4500 g.p.m. circulating water pumps. They are serving only the new condenser at present, but through a pump discharge header will serve all condensers in common with other pumps in the future. Duplicate condensate pumps remove condensed steam.

The air removal equipment has been located on the operating floor to permit easier operation. Although this location has been frowned upon at times by many engineers and operators, as a matter of appearance, it has been commended in this and several other cases by the operators. The use of a slight amount of care results in a creditable appearance which does not detract from turbine room appearance.

Switchgear and operating voltage presented outstanding problems to the extent that major changes were required. The systems had grown in load and capacity to the point where generation and city distribution at 2300 v. indicated the desirability of improvements. Losses were mounting and regulation was becoming noticeably bad. Similarly, 2300 v. conductors for a 5000-kw. unit would be undesirably large. The city officials wisely concurred in a decision to change to 4160 v. wye for both generation and city distribution.

Existing switchgear was old but by no means worn out. However, breakers were not suited for the interrupting and short time carrying capacities that could be imposed upon them by the improved plant. It was decided to avoid the installation of reactors and consequently new switchgear was purchased. Indoor metal clad, truck type, horizontal draw-out air-break switchgear was purchased for three generators, six feeders, and one bus-tie circuit. The latter circuit connects the new switchgear to the old switchgear through one wye-delta 4160/2300 v. pyranol filled transformer of 450 kv-a. capacity. A second similar transformer connects the two buses but is connected on the 4160 v. side to a lightly loaded city feeder through isolator switches. The 5000, 3000, and 2000-kw. generators are on the new bus and the 750-kw. unit is on the old bus The old switchgear was revamped to obtain a better supply for 2300 v. station auxiliaries as well as to station power transformers supplying

Table I. Load Growth

Year	Annual Generation Kw-hr.	Annual Demand Kw.	Annual Load Factor %	Per cent Annual Increase Generation	Demand
1928	2,118,990	650	37.2	...	....
1929	2,354,260	700	38.2	11.1	7.7
1930	2,929,920	800	41.7	24.5	14.3
1931	3,104,160	1000	34.4	5.9	25.0
1932	3,407,810	1200	32.4	9.8	20.0
1933	5,354,730	1500	40.7	57.1	25.0
1934	7,451,400	1650	51.5	37.5	10.0
1935	8,211,700	1800	52.1	10.2	8.3
1936	9,476,000	2100	50.5	15.4	16.7
1937	11,181,500	2600	49.1	18.0	23.8
1938	15,365,600	3200	54.6	37.5	23.1
1939	17,406,100	3350	59.3	13.3	4.7
1940	17,974,200	3300	62.0	3.3	(—) 1.5

Table II. Construction Costs

	Contract	Total Contract Cost
1.	Turbine driven boiler feed pump	$ 3,126.87
2.	Cooling Tower	13,966.29
3.	Cooling Tower Basin	4,862.07
4.	Circulating Water Lines	7,454.10
5.	Turbo-Generator	118,050.11
6.	Condenser	39,758.27
7.	Switchgear	50,970.37
7A.	Transformers	6,978.30
8.	Low-Pressure Heater	850.50
9.	Structure	30,143.04
10.	Power Piping	44,506.09
11.	Power Wiring	16,895.19
	Total Construction Cost	$337,561.20

lower voltage auxiliaries. These conventional transformers are located in two banks in a vault above the new switchgear. The bus-tie transformers are located in the open on the operating floor between the two sets of switchgear.

The new switchgear employs air breakers having an interrupting capacity of 150,000 kv-a. and are rated 600 and 1200 amp., 5000 v., insulated for 7500 v. Normal operation is with only one machine neutral disconnecting switch closed when two or more machines are in use. Adequate proof of the isolating qualities of the new gear was observed during phasing out operations. A temporary connection to phasing out potential transformers shorted inside the breaker compartment. The stationary studs in that compartment were badly burned, one disappearing. The removable contacts were damaged slightly. Leads to the breaker from the bus were sufficiently hot to show some heating. Breakdown did not occur and tests showed very little change in insulating qualities. The breakers cleared the short without difficulty. This unscheduled demonstration, although regretted by all, gave vivid proof of the previously made claims as to safety to man and equipment.

All high-pressure piping and some large low-pressure piping is of welded construction except at valves and connections to equipment. In general the piping connects to previously installed piping but the new steam, condensate and bleed lines are so located that they will match readily with future lines located in a piping bay to be created when the next boiler plant improvements are undertaken.

Circulating water pumps and lines are at the generator end of the unit under the switchgear. Thirty inch steel headers are arranged for ultimate extension to serve existing and future units. Connections to existing units were deferred until a later date. Headers are looped and are provided with single sectionalizing valves at both pumps and cooling towers.

The original mechanical draft tower installed in 1935 was a six fan, forced draft tower having a capacity of 5000 g.p.m. with 10 deg. F. approach to a 70 deg. F. wet bulb with 95 deg. F. inlet water. It is a spray tower. The new tower is a 4000 g.p.m., 3 cell, wood filled, double flow, 3 fan induced draft tower handling 95 deg. F. inlet water with 10 deg. F. approach to a 70 deg. F. wet bulb. Rise in noise level was limited to 40 decibles above normal when measured 10 ft. above tower base and 50 ft. away from open side of tower. In addition, objectionable noise of any intensity or frequency audible 150 ft. away was to be prevented. Sound meter tests indicated compliance with the specifications. It was found that traffic on an adjacent residential street produced more rise in sound level than did the tower.

A 140 g.p.m., 1200 ft. head turbine driven boiler feed pump was installed to replace an old duplex steam pump. A similar motor driven pump was later installed to replace another reciprocating pump, this improvement leaving the plant with two motor driven and one turbine driven boiler feed pumps.

These improvements were completed at a total cost of $337,561.20. Table II is a summary of construction costs including allocated costs for engineering, supervision of construction, and administrative overhead.

PRINCIPAL EQUIPMENT INSTALLED IN 1939-40 EXTENSION

Turbo-Generator

Elliott Company, Jeannette, Pa.

5000-kw., 6250 kv-a., 3600 r.p.m., 4000 v., 390 p.s.i., 675 deg. F. total temperature, 2 in. Hg. abs. back pressure. Direct connected, totally enclosed exciter.

Condenser

Westinghouse Electric & Mfg. Company, Pittsburgh, Pa.

7500 sq. ft. 2 pass., divided waterbox, 17 ft. by ⅞ in. Admiralty metal tubes, welded steel shell, twin 2-stage ejector units with separate shell inter and after condensers, duplicate condensate pumps, duplicate circulating water pumps.

Low-Pressure Extraction Heater

Ross Heater & Mfg. Co., Buffalo, N. Y.

213 sq. ft., 10 ft.-10 in. by ⅝ in. Admiralty metal tubes, Code shell, 4/1 passes.

Boiler Feed Pump

Ingersoll-Rand "Cameron" pump with Elliott Company turbine drive contracted for by the Elliott Company, Jeannette, Pa.

2 NT-6 pump, 140 g.p.m., 1200 ft. head, 225 deg. F. water, 3600 r.p.m. 390 p.s.i., 675 deg. F. steam, 0 to 10 p.s.i. exhaust.

Cooling Tower

Marley Company, Kansas City, Kansas.

4000 g.p.m., 3 cell, induced draft tower designed for 95 deg. F. hot water, 80 deg. F. cold water, with 70 deg. F. wet bulb.

Switchgear

Westinghouse Elec. & Mfg. Co., Pittsburgh, Pennsylvania, as contracted for by Zimmerman Electric Machinery Co., of Wichita, Kansas.

Metal clad switchgear for 10 circuits using air break switches with 150,000 kv-a. interrupting capacity and 50,000 amp. one second capacity.

Transformers

Graybar Electric Company, Kansas City, Missouri, for General Electric Co. equipment.

Two 450 kv-a., 3-phase, 2400/4160 v. two winding pyranol filled bus-tie transformers and three 150 kv-a. single phase 2400/4160 to 240/480 v. house service transformers.

Power Wiring

A. Tucker Electric Company, Topeka, Kansas.

Installing switchgear and transformers and electric connections all new equipment, changes in existing wiring, and rewinding 2000-kw. generator, and furnishing station battery.

Power Piping

Groeschel Company, Marshall, Missouri.

All power piping and part of circulating water piping. Additional piping furnished by Midwest Piping & Supply Co., of St. Louis, Missouri, for boiler feed pump and U. S. Pipe and Foundry Company for circulating water pipe.

Structures

Geo. Senne & Company, Topeka, Kansas.

Turbine room addition.

San Ore Construction Company, McPherson, Kansas.

Cooling tower basin.

MAKING THE LOW-PRESSURE STEAM SUPPLY DEPENDABLE

BY GEORGE L. RADAMAKER

Reductions in steam pressures of 3 to 1 and over are likely to cause difficulty so we asked the author to describe in detail the arrangement and equipment actually used in several representative plants where dependable operation and good regulation are necessary. Straight pressure reducing is the simplest but this is not always desirable from the standpoint of economy or feedwater. Two alternate arrangements are described where the reducing valve acts more or less as a standby, in one plant operating in parallel with low-pressure boilers, in another in parallel with industrial type evaporators

MANY INDUSTRIAL power plants are erected with high-pressure boilers and turbo-electric generators, but many auxiliaries, such as air ejectors, feed pumps, etc., use steam at a lower pressure. Also many industrial plants use low-pressure steam for process heating where temperatures and pressures must be closely controlled.

In one power station in the Middlewest steam is supplied from boilers at 460 lb. pressure and 750 deg. F. to a 25,000-kw. turbogenerator. In this plant steam must also be supplied, in conjunction with 150 lb. pressure boilers, for use in reciprocating steam engines, turbines, steam hammers, oil heaters, and other equipment as shown by Fig. 1.

In order to supply steam to the low-pressure equipment the steam must be reduced from 460 lb. ga. 750 deg. F. to 150 lb. and 500 deg. This is accomplished by two methods: 1, evaporators, in which high-pressure steam is condensed and gives up its heat to a poorer and thus cheaper grade of feedwater; and 2, reducing valves, in which the high-pressure steam is reduced directly by automatic regulators and the temperature is reduced by injection water supplied by desuperheater pumps. Figure 2 shows how these two methods are used simultaneously.

Some idea of the conditions in the plant is apparent when it is realized that in addition to steam supplied by low-pressure boiler houses, 250,000 lb. of steam must often be supplied by the evaporators and reducing valves in the central station. In the operation of this plant, steam from the evaporators is given precedence over the steam used from the reducing stations. Since a more pure boiler water is used in the high-pressure boilers it would be wasted by being sent through the reducing valves.

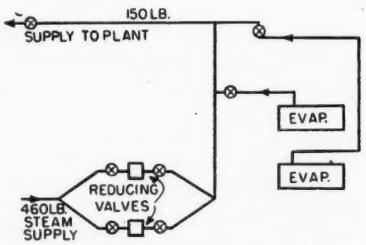


Fig. 2. Diagrammatic arrangement of equipment to supply 150 lb. steam from industrial evaporators or heat transformers with an emergency supply through reducing valves

Therefore a more impure feedwater is supplied to the low-pressure shell of the evaporator to be turned into 150 lb. steam and the high-pressure steam is condensed and returned to the boilers through boiler feed pumps. The reducing stations are merely used for standby in case the load is too heavy for the evaporators alone, or the evaporators are out of service for repairs.

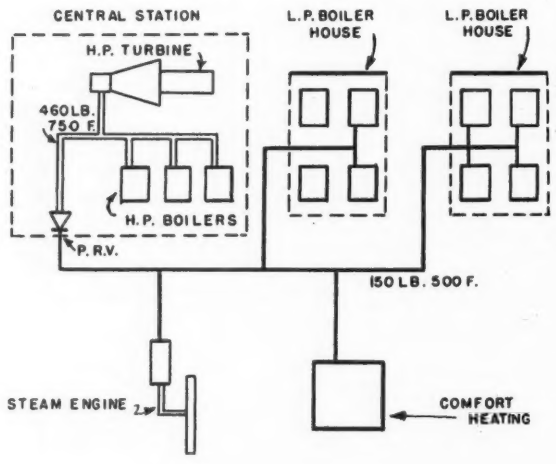


Fig. 1. (Above) Arrangement of one plant where 150 lb. steam is supplied from low-pressure boilers as well as a pressure reducing valve from high-pressure boilers

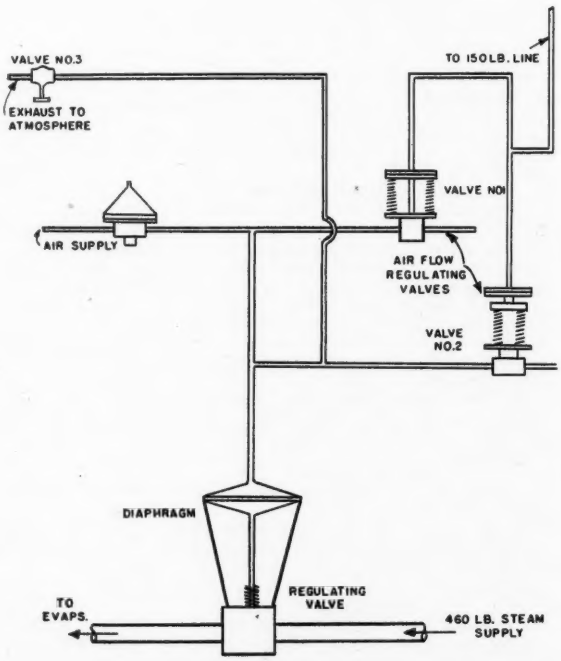


Fig. 3. (Right) Details of the air operated reducing valve and the control valves and adjustments for automatic pressure regulation

Under normal plant conditions the evaporators are operated at maximum capacity and load swings are taken care of by the reducing stations. Also it has been found in the above plant that if load conditions are balanced throughout the plant so that the evaporators handle the load changes, the pressure curve is not as smooth as when the evaporators are run at capacity and the load swings are taken care of by the reducing stations. The regulating valves of both the evaporators and the reducing stations are operated by air pressure supplied from an air compressor used only for control purposes.

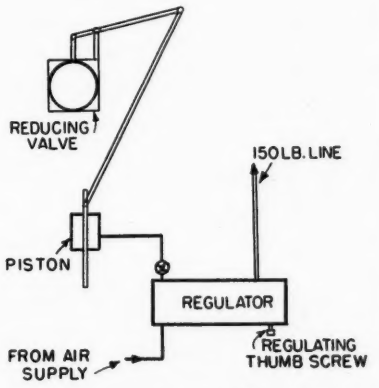


Fig. 4. Diagrammatic arrangement of an air operated pressure regulator arranged to operate a reducing valve

The system of valves and regulators which control the steam to the evaporators and consequently the low-pressure steam from the evaporators is shown in Fig. 3 and is operated as follows: Air is supplied to the diaphragm of the steam regulating valve through an orifice from the air compressor. The pressure of the 150 lb. steam line is regulated by varying the tension of springs on the air flow regulating Valves 1 and 2. By decreasing the tension in the coil springs more air is bled through to the atmosphere, thus decreasing the air pressure on the diaphragm valve. This consequently decreases the steam to the evaporator and results in a drop in the pressure of the 150 lb. steam line.

Number 1 bleed valve has four adjusting screws used to regulate the air bled and thus control the steam pressure. Number 2 bleed valve with two adjusting screws is set so that air will bleed to maintain a pressure not to exceed a certain predetermined limit (about 160 lb. in this case). Its purpose is purely an emergency one.

Some regulation can be effected by cracking Valve 3 which is located on the operating floor. This also drops the air pressure on top of the diaphragm valve having the same effect as above. Regulation of Valve 3 results in limiting the load capacity of the evaporators, so that if this method is used the steam pressure must be watched constantly in case of a sudden pick up in load. This valve is also used in case load must be dropped from the high-pressure boilers immediately. By opening this valve wide all pressure is relieved from the diaphragm and the steam valve is closed.

A much more positive pressure regulation is obtained by the reducing valves as shown diagrammatically in Fig. 4. Air is supplied to a patented regulator which in turn proportions the amount of air necessary to a double acting piston which in turn regulates the amount of steam passing through the reducing valves. The pressure on the 150 lb. steam line can be regulated by a thumb screw at the bottom of the pressure regulator. This thumb screw is set so that the maximum steam is produced by the evaporators and only cuts in the reducing station when necessary to maintain the line pressure.

Temperature of steam is practically constant coming from the evaporators as this is a quality that is inherent in the design of the evaporators and has no regulation. Steam supplied to the reducing station is at 460 lb. pressure and 750 deg. F. and must be reduced to about 500 deg. F. and 150 lb. pressure. This temperature reduction is accomplished by injecting water from a desuperheating pump, the amount being controlled by a thermostat.

Of course, the 150 lb. steam may be further reduced for process work in the plant, but it is much easier to reduce steam from 150 lb. than from 460 lb. down to where needed, and besides is much more efficient.

INCREASING CAPACITY AT LOW COST

BY H. C. LINDERMAN
Central District Stoker Engineer
Westinghouse Electric & Mfg. Co.
Pittsburgh, Pa.

INCREASING THE steaming capacity 36.5 per cent in one of the U. S. Gypsum Co.'s largest plants near Port Clinton, O., has been accomplished by a power plant modernization program. By the installation of the latest type link-grate continuous - ash - discharge stokers, economizers, induced-draft fans, and water-cooled bridge wall for the boilers, the steam rate has been increased from 93,000 to 127,000 lb. per hr. With the continuous-ash-discharge link-grate construction added to the stokers, it has been possible to burn lower grades of coal at a substantial saving in cost delivered to the bunker, giving a marked increase in fuel burning economy and a decided decrease in maintenance cost of furnace brickwork and fuel burning equipment. The overall steam generating cost on a yearly basis has been sufficiently reduced to amortize the investment in less than 3 yr.

The plant was originally equipped with four 427 hp. straight tube boilers and multiple-retort underfeed stokers of the double-dump-grate type. The peak demand on the boiler was at times as high as 90,000 lb. of steam per

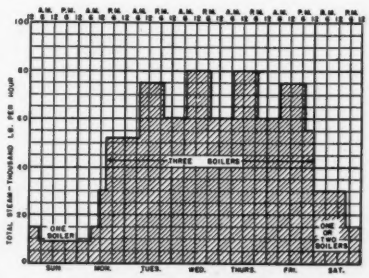


Fig. 1. Typical boiler loadings under 1940 conditions

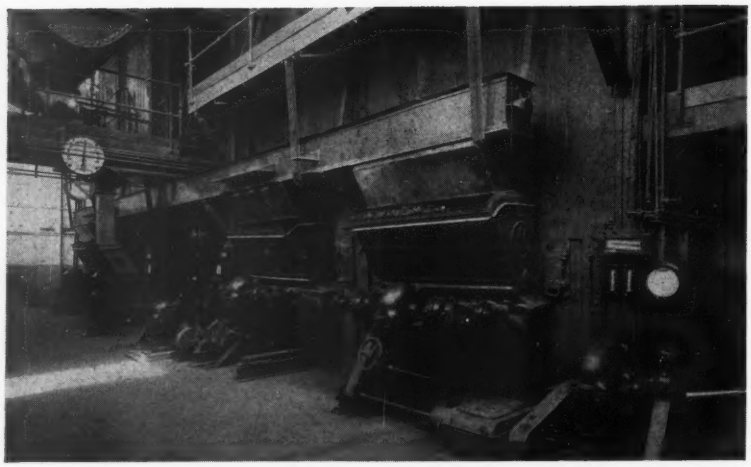


Fig. 2. Interior of one of the U. S. Gypsum Co.'s largest power plants located near Port Clinton, O. By modernizing the stokers and installing economizers, induced-draft fans, and water-cooled bridge walls for the four boilers the total steam rate has been increased 36.5 per cent—from 93,000 to 127,000 lb. per hr.

hr., corresponding to 22,500 lb. for each of the four boilers when operating at 160 per cent of rating. In order to carry this demand on three boilers, with one as a stand-by, the limits of fuel burning on the dump-grate stokers and draft available from the stack left no margin for safe and economical operation.

Modernizing the stokers and adding water-cooled bridge walls permitted the entire grate area within the confines of the existing furnaces to be effective resulting in a 17 per cent increase in grate surface. This allowed a substantial saving in reconstruction of furnace brickwork, foundations, and basement details. Economizers and induced-draft fans were added such that one economizer could be used with either one or two boilers.

All demands imposed upon the plant thus far have been successfully carried with three boilers, thus leaving the fourth boiler available for spare and regular rotation of cleaning periods. This in itself has effected a considerable improvement in overall performance and maintenance cost of the equipment.

The plant operates on a 5 da. schedule, and requires steam in varying amounts at all times as shown by the typical steam flow chart. Standby and banking losses would introduce a serious problem but for the unusual flexibility of the fuel burning equipment and the even distribution of the load between the boilers. A tabulation of data for 1938 shows that No. 1 boiler was in service 4,963 hr. at an average rating of 114 per cent, and was on bank for 839 hr. at an average rating of 49 per cent. Corresponding figures for the other three units are: No. 2, 5,571 hr. at 116 per cent and 793 hr. at 57 per cent; No. 3, 4,892 hr. at 121 per cent and 554 hr. at 56 per cent; and No. 4, 3,056 hr. at 124 per cent and 242 hr. at 65 per cent. The diagram in Fig. 1 shows a typical week's operation in 1940.

The original plant, located at Sandusky Bay, near Port Clinton, was built around 1890 at the site of extensive gypsum deposits. The original mill, which burned down and was rebuilt in 1907, has been a continuous producer of plaster products ever since.

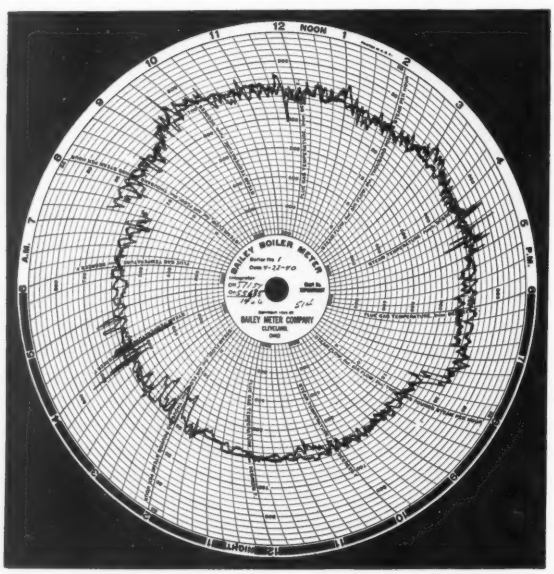


Fig. 3. Boiler meter chart for No. 1 boiler showing the hourly output and performance. On this day Boilers 1, 2 and 4 were operating, the load being divided quite evenly. The integrator readings were 1466, 1382 and 1442 respectively for Nos. 1, 2 and 4

Stokers and National Defense

ADDRESSING the Stoker Manufacturers' Ass'n, J. E. Martin, Manager of Stoker Div., Link-Belt Co., discussed problems of stoker manufacture and merchandising as affected by national defense activities.

Design will follow present patterns closely because of scarcity of tool and die makers and machine tools. Possible rationing of raw materials such as aluminum, steel, zinc, and alloys may necessitate substitution of other metals and plastics in some parts of the design as alternatives. Taxes imposed to reduce consumption of "non-essential" items may affect stokers as well as oil and gas burning equipment. Restriction of down payments and credit time allowed on installment sales may produce some market limitation.

On the other hand, more money in circulation, more people interested in automatic heat, and aggressive merchandising of improved designs will tend toward increase in stoker sales. Possible restriction or price increase of petroleum products will work for larger price differential between coal and oil.

Under defense activities, requirements for power and heat will be greater in cantonments, and industrial plants, and conservation of fuel by use of stokers will be important in lowering cost and increasing plant capacity. Stokers for anthracite, where this fuel is economical, as well as for bituminous coal should be made available.

Immediate reduction in steam cost of 12 per cent, with plans for future high pressure operation, additional heat recovery equipment and a top turbine provided for the Hobart Manufacturing Co., Troy, Ohio, by a new power plant extension

New Boiler Cuts Steam Costs

WHILE the modern central station cycle is more complex, the engineering involved in providing a definite capacity for the single purpose of generating electric power is generally much simpler than the average industrial plant problems involving considerable quantities of process and heating steam as well as electric power.

In spite of a few outstanding examples, however, the average quality of industrial plant engineering is not high. Rule of thumb methods are still common, little consideration is given to the problem as a whole, and an undue amount of detail and responsibility is thrown on the shoulders of manufacturers who supply individual pieces of equipment.

The final result is steam and power, without however the reliability, first cost and operating economy that should be expected. Only too often the final result is comparable to assembling half a dozen parts made for a finely jewelled Swiss watch in a dollar watch movement.

One of the exceptions to this common practice is the recent power plant extension program of the Hobart Manufacturing Co. at Troy, O. The program was engineered to take full advantage of the old equipment; provide for present needs at low first cost and high efficiency; and to allow for future expansion of either steam or power services as the need arises.

The whole development is made doubly interesting by the fact that it was worked out for what may be taken as a typical American industrial plant and involves no radical departure from established practice. In fact the plant itself tends toward the conservative with reliance placed on equipment in which the engineers had confidence through favorable first hand experience in the past under comparable service conditions with both Ohio or West Virginia coal.

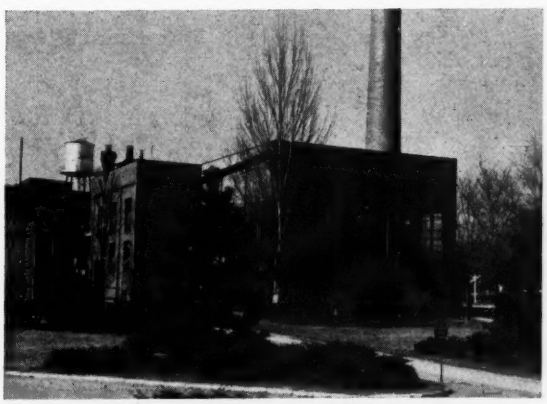


Fig. 1. The new boiler is installed in the ell shaped extension to the power plant just to the left of the pine tree. When needed further extension of the building the full depth of the power plant will provide space for a top turbine

While the Hobart Manufacturing Co. has one of the world's largest plants devoted exclusively to the manufacture of food preparing machinery (such as meat choppers, meat slicers, coffee mills, peelers, mixers and scales), steam and power requirements are typical of the average medium sized industrial plant. Electric power is both generated and purchased, considerable quantities of high-pressure process steam are needed and there is, of course, a heavy winter heating load.

Up to last year the power facilities for Plant No. 1 consisted of two 323-hp. boilers fired by underfeed stokers and one 750-kw. turbo-generator taking steam at 215 lb. and exhausting to a 1250 sq. ft. surface condenser. Automatic extraction at 5 lb. ga. provided steam for the heating system. Two small boilers operated at 125 lb. pressure and originally took care of the steam requirements of Plant No. 2, but these were discarded in 1940 after a steam line was built to take care of the requirements from the main power plant.

Feedwater make-up, amounting to approximately 20 per cent,

was supplied through a hot process softener located on the main floor. A conveyor system elevated the coal from the track hopper to a 110 t. overhead bunker at one end of the boiler aisle. From the bunker it was distributed to the stoker hoppers by means of a weigh larry. Overflow from the bunker spilled to a 700 t. outside storage located between the track and plant. Coal was reclaimed from storage and again elevated to the bunker by the same conveyor system used for unloading the cars. Ash was removed from the plant in wheelbarrows.

In addition to the extra load thrown on the main plant after the steam line was built, two new buildings were added in 1940. The heavy winter load of about 35,000 lb. per hr. forced the old boilers and resulted in high maintenance costs and inadequate standby capacity.

Under the circumstances additional boiler capacity was a necessity and after a thorough study of present and probable future load conditions the program mentioned earlier was decided upon. Two 17 ft. bays were added to the boiler house to provide space for a 472-hp. boiler, stoker fired, with forced draft and complete combustion control. A new deaerating feedwater heater and a complete steam jet ash handling system were installed at the same time.

The new boiler, which will be described in detail later, took care of the immediate steam needs. Equally important, it serves as the first step in a far reaching program which can be completed step by step as circumstances demand.

Under this plan the original plant equipment, which has been fully depreciated but which was well maintained and still in good condition, will be utilized to the maximum. The old boilers are entirely adequate and will be used as standby for the single new boiler. This boiler while designed for 400 lb. pressure is being operated for the present at 215 lb. ga. 100 deg. F. superheat, supplying steam through a reducing valve, 125 lb. steam to Plant No. 2, and direct to the 750-kw. condensing-extraction turbine. The performance of the turbine has been materially improved by this arrangement, for the new boiler supplies steam at the design temperature of the turbine, or about 35 deg. F. higher than the old boilers.

At present the peak electric load runs about 1300-kw. Part of this power is generated on the 750-kw. unit and part is purchased from the local municipal system. Normally the night and week-end load is carried on purchased power and the turbine shut down. This arrangement has proved satisfactory and economical in the past and will probably continue to do so for some time to come. However, the continued growth of the company plus the fact that the municipal system load is also growing and may in the future find it difficult to supply such a block of power to a single customer, made it advisable to look forward to a possible extension of the power generating facilities.

Consequently the boiler was purchased for 400 lb. operation and with space provided for additional superheater elements to increase the total steam temperature to about 600 deg. F. This will permit the installation of a small topping turbine, or in the event that future steam and power requirements justify it, another condensing extraction turbine. Space can be made available for both another turbine and another boiler. Thus the future is provided for in a flexible way, without involving extra investment which would hamper changes should future developments make this advisable.

High-pressure operation would justify additional heat recovery equipment, so that the extension steel work has been designed to accommodate a penthouse as shown by Fig. 2. This penthouse will house a separate economizer and induced draft fan. The hot process feedwater softener is entirely adequate for any reasonable increase in load, the new 60,000 lb. per hr. Cochrane deaerating heater, installed with the new boiler, will materially improve feedwater conditions and is large enough to handle twice the present load.

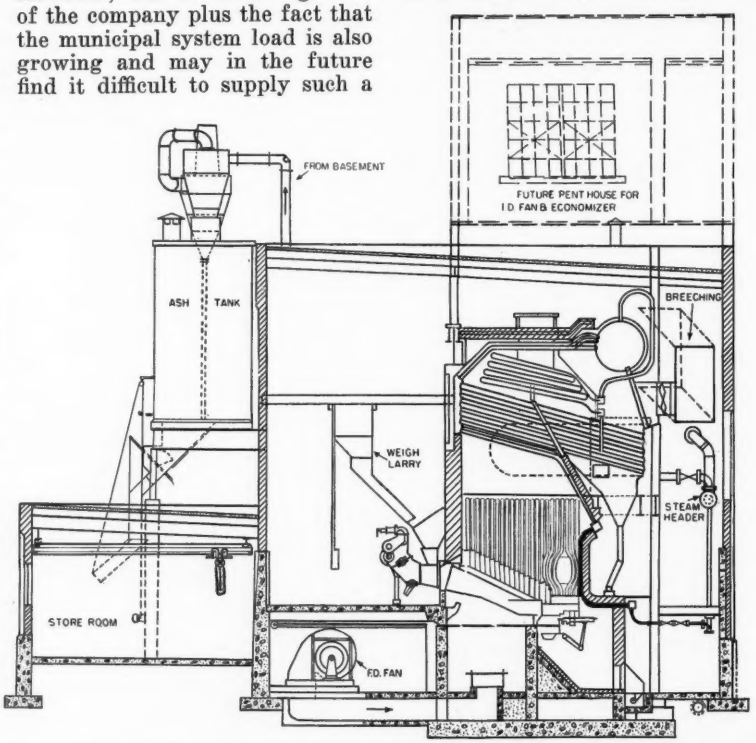


Fig. 2. Cross section of the new extension showing the new ash tank, boiler, stoker and forced draft fan. The building steel is designed so that a penthouse, shown dotted, can be added later to provide space for a separate economizer and induced draft fan. Coal is supplied to the new stoker hopper by a weigh larry from the existing bunkers. An outside coal yard, just back of the machine shop, provides storage for about 700 t.

Inasmuch as the new boiler will be operated at 215 lb. for some time to come, new boiler feed pumps were not purchased. The old boiler feed pumps in the basement are being used for the new boiler. The new United Nuveyor ash handling system and ash tank were installed primarily in connection with the new boiler, but the suction lines were extended to serve the old boilers as well at little additional cost. Coal supply to the new

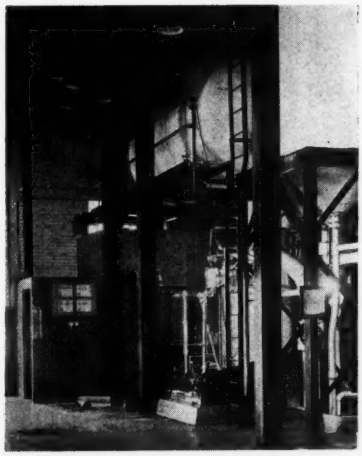


Fig. 3. With the new boiler a deaerating feedwater was installed, located over the water softener in the existing building. The boiler feed pumps are in the basement and two old boilers are just to the right of this photograph

boiler was handled simply by extending the weigh larry rails.

The new boiler unit, Fig. 2, is a 472-hp. Springfield straight tube type with water cooled side and rear walls. The front wall is air cooled with provision for overfire air introduced through openings about 2 ft. above the fuel bed. This secondary air is taken from the windbox and controlled manually by the operator by means of a damper, with the operating lever extending out to the side of the stoker.

This stoker is a Taylor six retort, underfeed with continuous ash discharge, a projected grate area of 124.7 sq. ft. and driven by a Terry turbine. The design capacity of the unit burning West Virginia coal is 50,000 lb. per hr., or burning Ohio coal 40,000 lb. per hr. At present it is operated at 215 lb. ga., 100 deg. F. superheat, but is designed for 400 lb. ga. working pressure. Both the feedline, which was welded into the old feedline, and the steam line, connected to the old header, are designed for the higher pressure.

Forced draft is supplied by a Green fan located in the basement and driven by an Elliott, 25-hp., back geared turbine designed for 375 throttle and 5 lb. back pressure operation. This turbine exhausts to the deaerating heater and heating system. The fan unit has both damper and variable speed control. The combustion control power cylinder operates the louvre damper direct and from the damper a cable connection opens or closes a valve in the steam line to the turbine as the damper approaches the closed or open position.

Complete automatic control is provided by an Askania combustion control system centered on the panel shown in the photograph at the top of this article. In addition to the control equipment the panel has a Bailey boiler meter, a Bailey 5 pointer draft gage, two Ashcroft indicating pressure gages and a Bailey recording meter for the steam pressure, steam temperature and feedwater temperature.

Other boiler accessories and equipment include: a Copes feedwater regulator; Diamond soot blowers; Philip Carey insulation throughout; Yarway blow-off valves; Edward stop and check valves; Reliance water columns; Illinois traps; and a Fisher 215/125 lb. reducing valve.

At an average heavy load of 30,000 lb. per hr., burning 13,700 B.t.u. coal with a feedwater temperature of 230 deg. F. and 13.4 per cent CO_2, the efficiency of the new unit is 81.6 per cent, giving an evaporation of 10.26 lb. of water per lb. of coal. This is approximately 12 per cent more efficient than the old boilers. Due to light week-end and night loads, however, the average load is much below 30,000 lb. per hr. and the flatter efficiency curve, the new unit shows a greater average saving than these figures would indicate.

Several weeks' operation, including week-ends and night loads, show the new boiler gives an average evaporation of 9.88 lb. or an efficiency of 79.9 per cent. As a result of this higher efficiency steam costs have been reduced from 37c to 31c per thousand pounds, approximately 12 per cent. These figures cover operating cost, labor, fuel and maintenance only. Depreciation and fixed charges have been omitted for the old boilers were written off the books long ago.

Outside of the careful planning involved, the outstanding feature of the installation is the fact that careful design and operation of simple, standard but modern, equipment make possible boiler efficiencies in the neighborhood of 80 per cent in comparatively small sizes. This is a matter of considerable import-

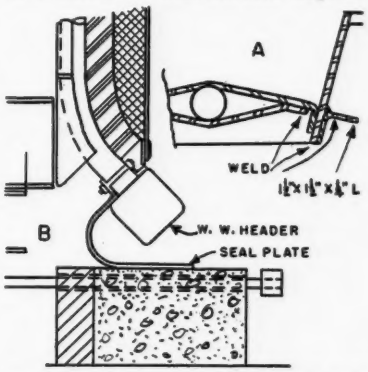


Fig. 5. Details of: A, the ashpit air seal; and B, the air seal between the side water wall headers and the floor

ance to the average industrial plant where size and loads do not justify large investments in heat recovery equipment.

Equally important is the matter of trouble-free operation. While the boiler has not yet been operated at maximum capacity, nor have various kinds of coal been experimented with, operation with the East Kentucky coal used in the plant for some time has been highly satisfactory. Loads as high as 35,000 lb. per hr. have been carried, the clinker formation is negligible and seldom interferes with ash discharge to the point where clinkers must be broken up to pass through the 8 in. ash line.

W. I. Barrows of Dayton, O., was the consulting engineer; John M. Sherman is plant engineer of the Hobart Mfg. Co. and Vernon Edwards is chief engineer of the power plant.

Fig. 4. The turbine driven forced draft fan is located in the basement. The combustion control actuates both a louvre damper on the fan discharge and a valve in the steam line to the turbine

NAPOLEON and the Boiler Baffles

"Sacre Bleu! Ze boiler she have no baffle!" said Napoleon, who fired the coal, but the Chief didn't believe much in baffles—that is until the war prodded the Boss into hiring a B.t.u. detective. Inadequate supervision is a common plight in many small plants

By Joseph W. Hays[1]

IT WAS in the winter of 1917-18. The United States was teetering upon the edge of the war cauldron. Every plant in the United States was busy. Britain and France needed supplies and materials of all kinds. Our industries were keyed up for production, but we ourselves had not yet armed. Every plant that could make anything at all was busy making it. The demand for machine tools and power plant apparatus was far beyond the abilities of the manufacturers to supply. There was an enormous demand for everything, including paper. It was a wild and feverish time and every plant had to do the best it could with what it had.

The Snows Were Deep

In the middle of the winter a wire came asking me to visit a paper mill near the Canadian border and to get there as soon as possible. The snows were deep all over the East and double-deep in the Adirondacks and along the border. The train was late but the president of the company himself, a Mr. "Brown" was waiting. He had left his office in the city for the company's "bottle-neck" in the plant and was wearing laced boots, a fur-lined coat and an unmistakable appearance of worry. He said: "Old man trouble is certainly here with all of his tools and he is walking all over me wearing calks and spurs. The trouble is that we can't work our plant at anything like its capacity. When the digesters are taking steam we can't operate the paper machines and when they are operating we can't use steam in the digesters. For the first time in the history of this company we have a chance to make plenty of money. But we can't make money unless we make paper. Orders are piling up on us at unheard of prices and we are threatened with cancellations for non-delivery. Am I in trouble?"

In his opinion the trouble was in the boiler room. He had ordered two additional boilers,—"small second-hand boilers" the only ones he could buy but on which he could not get delivery for another 90 days. The plant engineer approved the additional boilers, but thought that steam was being wasted in the plant. Mr. Brown said "Your job is to find the trouble and tell me what it is. You will stay here until you do that. Nobody but my secretary at the city office knows anything about you. You can get into the boiler room at any time of day or night without a pass and I will be at the mill office between 8 and 9 tomorrow morning."

His Mind Was Blank

I knew absolutely nothing about that boiler plant except that a lot of trouble was supposed to be lurking there and I was really glad that Mr. Brown had been so indefinite. My mind was as blank, respecting that boiler plant, as a white sheet of paper. It was open to any and all impressions that it might receive and the first thing that it received, as I approached the door of the boiler room, gave me the key to the entire problem.

A fireman was in front of one boiler cleaning the fire and swearing in picturesque Canadian-French. After cleaning I watched him fire the furnace. He was a skilled fireman. He knew his business and whatever the trouble might be I could give him a clean bill. He sat down, wiped away the sweat and filled his pipe. I filled mine and sat down beside him. Then we talked. When he went back to fire again I walked through the boiler room. Everything that I saw confirmed my first impressions and I then had another talk with Napoleon.

Did he know Mr. Brown? No, he had never seen him. If ordered to do so would he go to the office and answer every question that I might ask him and tell the exact truth in every case as he had told it to me? "By Gar, you send for me, M'sieur, I come." When Mr. Brown arrived we arranged for a meeting. It started about 10:30 and lasted until about noon. A stenographer was called in to take down the proceedings and Mr. Brown said, "Your meeting, Mr. Hays."

I explained that we were trying to ascertain why the steam plant could not carry the mill load and that each one would be given a chance to offer his own explanation in his own way and that there must be no argument. I said, "I will now ask some questions, beginning with you, Napoleon. Mr. Brown will back me up when I say that nothing will happen to any one of you if you tell the truth without hedging.

Napoleon Speaks—and How!

"Now, Napoleon, when I approached the boiler room this morning I noticed that the steel stack was extremely hot, blue hot, almost red hot. I asked you about it. You told me why. Please tell Mr. Brown."

"Mr. Brown, ze baffle is all gone in ze boiler."

"All right. Now explain to Mr. Brown what you mean by 'baffles' and what the baffles do."

"Mr. Brown, ze baffles are ze brick zings which go between ze tubes and make ze gases go where zay make ze steam." Napoleon explained that he had been firing that boiler for 6 mo. and that there had

[1]Mr. Hays, who is probably the best known combustion engineer in the country, was recently presented a scroll by the Chicago Section of the A.S.M.E. as a token of distinction of his achievements and public service as a combustion engineer.

been no baffles in the boiler at any time since he first went on the job.

Asked if he had ever told anybody about the baffles, he said that he had complained three times to the head fireman and "he always say 'Get ze hell back to ze boiler and fire ze coal.'" He said that he had also complained to the Engineer and the Chief Engineer and wound up by saying, "I work like ze hell, I burn much coal all ze time ze boiler she no make much steam."

It was plain to be seen that Mr. Brown was getting mad. The head fireman explained that he had known about the baffles and had spoken to the Engineer about them. His own job was to see that the boilers were properly fired and that they got water. He had nothing to do with repairs. He had also spoken to the Chief Engineer. The alibi had to be accepted.

Mr. Brown Gets Madder

Mr. Brown's face showed that he was getting madder. He glared at the engineers. The Engineer admitted that he knew about the baffles and had talked with the Chief about them. He was only one of the Watch Engineers and his duties were all outside the boiler plant. He had nothing whatever to do with boiler upkeep. His alibi had to be accepted. Questioned as to the function of boiler baffles he was non-committal.

The Chief Engineer said that he had never believed much in baffles, that there were no baffles in the boiler when he first came to the plant 6 yr. ago and that if there ever had been baffles in that boiler they had "fallen out" on some other engineer and not on him.

There were no boiler baffles in stock anywhere about the plant and we called New York. It would take two weeks to get the baffles there by freight. "Believe it or not" the baffles were ordered shipped by express. I spent 3 days in that plant making as careful an inspection as possible under the circumstances. I made the following recommendation:

"When the boiler is shut down for the installation of the baffles, have it inspected by a regular boiler inspector. Have the boiler thoroughly cleaned, inside and out. Be sure that the setting is repaired and made tight and that everything else about that boiler and its accessories is 100 per cent. Then shut the other boilers down, one at a time, and give each of them the same treatment."

Heat Treatment For Diesel Cylinders

Process developed for hardening the bores of Diesel cylinder liners now in use by tractor manufacturer

APPLICATION of induction heat treatment to the bores of cast-iron cylinder liners used in its entire line of Diesel tractors has been announced by Caterpillar Tractor Co. This is the first 100 per cent production application of electro-magnetic heating to the cylinder bores of internal combustion engines, and is an adaptation of the revolutionary process developed by Budd Induction Heating, Inc., a subsidiary of the Budd Wheel Co. of Detroit, which has released a statement that the treatment produces an inside surface of controlled hardness, depth from the surface, and area in the bore of the liner, resulting in a longer-wearing sleeve with markedly improved physical properties.

In this installation, to which Caterpillar has applied the trade name "Hi-Electro", the heat treating machine hardens the inside diameters of the cast-iron liners to a surface hardness of Rockwell "C" 52 to 55, which is subsequently tempered to a slightly lower hardness. Depth of the hardened area developed is approximately 0.070 in. Liners from 10 to 15 in. in length, with bores varying from 3¾ to 5¾ in. in diameter, for the different sizes of Diesel engines are in production. Following the operation of hardening and tempering, the bores are honed to the final finish, before "surfiding" after which the outside surface is finish-turned for insertion into the cylinder blocks.

The finished sleeve is reported to be superior in physical characteristics and wear-resistance to any which have been previously produced. While the bores are extremely hard, providing maximum resistance to wear, the sleeves are not brittle. Quality and uniformity of product are maintained at the highest standards.

An interesting feature of this method of heat treatment is the fact that the hardening operation serves as an additional check on previous inspections of the units treated, as the treatment serves to emphasize any porosity or imperfections which may have escaped visual and surface examinations.

How the Process Works

Differential hardening by electro-magnetic induction is accomplished through the concentration of high power, high frequency currents in the surface zone to be hardened. As applied in the Budd method of hardening the inside diameters of cylindrical objects, such as cylinder liners, the currents are caused to flow almost entirely in the shallow internal surface zone to be heated and to be so concentrated that the temperature of the zone affected is raised to hardening temperature before any substantial amount of heat can drift to the remainder of the piece.

In this way, the required heat is almost instantaneously generated in the zone to be hardened. This thermal energy is then "trapped" through the immediate application of a controlled water quench. An extremely hard surface is thus obtained, while the remainder of the cylinder, due to the speed of the operation, has remained relatively cool and has therefore not been affected from the viewpoint of hardening.

Fig. 1. A Diesel cylinder sleeve being placed in the Induction Heat Treating Machine for the hardening operation

As the power input and timing of the current application, and the volume, pressure, and angle of direction of the quench are accurately controlled, it follows that the hardness developed, depth of the hardened area, and the area treated are also controlled within exceedingly close limits. The time required for the entire heating and quenching operation is a matter of but a few seconds.

Development of the Budd Induction Method of heat treating inside diameters was undertaken with a specific aim in mind. It had long been recognized that if the bore of a cylindrical object could be hardened, while the remainder of the part was held in an undisturbed and machinable condition, the entire manufacturing operation would be simplified. Existing methods of hardening did not meet design and production requirements.

The aim was to develop a hard, wear-resisting bore on the inside surface of a cylinder, while leaving the remainder of the unit undisturbed. This having been achieved, improved physicals would naturally result; for example, greater resistance to bursting or collapse would follow if this metallurgical condition could be attained.

It was also hoped that a wider range of materials, including nonalloyed ferrous metals as well as the alloyed, could be satisfactorily treated, thus making possible less costly and more satisfactory designs.

All of these advantages have been realized. Further, a control system which operates automatically assures uniformity of hardness throughout the treated area, uniformity of area treated, and uniform depth of areas hardened, thus assuring steady production of units of controlled metallurgical properties.

Fig. 2. End view of a Caterpillar Diesel cylinder liner showing hardened zone, which is approximately 0.070 in. deep, in the slots milled in after the hardening operation.

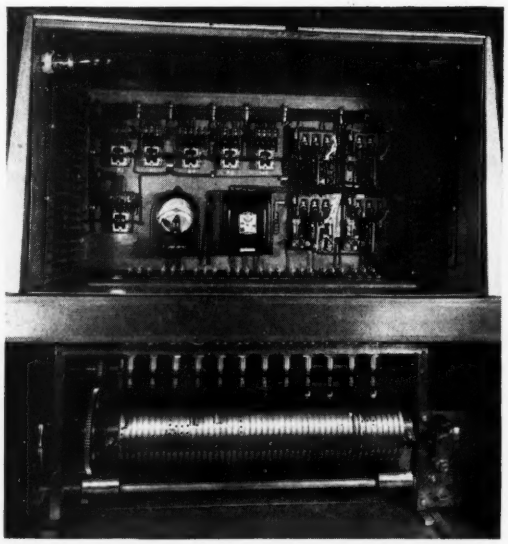


Fig. 3. The automatic controller maintains all of the timed sequences and consists of a series of precision cam-operated switches. The revolving drum on which the cams are mounted, may be seen in the lower part of the photo. In this case the drum is arranged to receive four sets of cams, the different sets controlling the operations for different sizes of cylinders to be treated

Some Details of the Machine

The operation is accomplished through the use of a carefully engineered induction heat head which is drawn evenly through the bore under treatment, or conversely the part is drawn progressively over the heat head. As this head travels through the bore, a high frequency current is applied, causing the magnetic lines of force which result in heating of the metal under treatment. This operation is followed immediately by the controlled water quench.

Tailored Cylinders

The process makes possible the production of improved units in nearly every type of machine in which cylindrical metal bores are subject to wear or stress. Hardness is produced at points of greatest wear, while a tough, ductile core is retained to provide maximum strength. Physicals of the parts treated are, in effect, tailored to fit wear and strength requirements.

Further, where design permits, the outside surface, and all other unhardened areas, can be machined after heat treatment of the inside surface of the bore. As the depth of the hardened area is accurately controlled, the area which can be machined after the bore has been hardened can be very precisely determined.

Metallurgical Considerations

In materials containing temper or uncombined carbon, recombinations of this carbon at a greatly accelerated rate can be accomplished through this method of induction heat treatment, thus markedly increasing the hardenability and strength of the area treated. The grain size of the treated material may be made consistently smaller, which is an advantage in most applications as improved physical properties can be developed in this manner.

Gross distortion, scaling, necessary straightening, decarburization, the necessity for using more stock in order to compensate for adverse distortion, and grinding checks due to lack of uniformity of structure, are no longer problems. The short cycle, in combination with the rapid quench which follows, virtually eliminates oxidation.

ARC WELDING of brackets to the radiators of transformers, where metal was less than ¼ in. thick and 5 in. of weld were required in four places (all within 1 ft. radius) was accomplished at Ironwood Substation of Lake Superior Dist. Power Co. without removing oil from the transformers. One inch of weld was applied at a time and then allowed to cool so as to avoid heating the oil to ignition temperature. The job was finished in 3 hr. without taking transformers out of service, thus avoiding shut down of the 33,000 kv-a., 88,000-v. equipment. The work was done by Stanley Richard of Ironwood and reported by Hobart Bros. Co.

Co-ordination of Water Conditioning With Operating Problems. I

BY R. E. HALL AND C. E. KAUFMAN
Hall Laboratories, Inc.
Pittsburgh, Pa.

Characteristics of modern boilers have placed complex water treatment problems on the operators, as indicated by the authors in the introductory paragraphs of this article, the first of a two-part serial. The higher pressures and larger sizes of boilers now in common use result in fewer spare boilers available in case of trouble, a condition demanding reliable water conditioning. In this article the authors discuss the maintenance of a protective film, the control of alkalinity for which an original curve is presented and the prevention of embrittlement. Part II of the series will deal with the prevention of deposits in the boiler

BECAUSE of the characteristics of modern boilers, the water conditioning problems thereof have become more complex, and the necessity for immediate diagnosis and remedy of trouble more urgent. The higher pressure and the larger size or steam output of modern boilers result in fewer spare boilers available in case of trouble, and much enhanced loss from the outage of any units whether unscheduled or planned. Each step-up of operating pressure signifies a higher temperature both of metal and of water. Inasmuch as both steel and water—all substances in fact—increase in chemical reactivity with rising temperature, the problem of preventing their direct attack, one on the other, becomes more acute.

When steel and water are in contact, a continual struggle is on for the combined oxygen in the latter. Steel wants it, hydrogen has it. Even at ordinary temperatures, steel slowly wins, as shown by introducing fine pure iron powder into water free of dissolved oxygen, whereupon the iron powder slowly takes the oxygen, and hydrogen gets out of the way as hydrogen gas. Rising temperature is the "Reno" for speeding up this divorce and remarriage. Likewise, the largely increased heat input per square foot of heating surface of the modern boiler makes it unequivocally a necessity that circulation supply ample water to its labyrinth of tubes, headers, and drums. Otherwise the metal suffers, either by destructive chemical reaction with the steam, or from overheating caused by deposits resulting from the too-complete evaporation of the water.

As our title states, our purpose is to show how water conditioning must be co-ordinated with the operating problems. Our journey to this goal starts with establishment of the recognized principles of water conditioning, and then follows along the path of their use, first, in diagnosing the causes of troubles that may develop, and second, on the basis of diagnosis in establishing the necessary remedial measures.

*From a paper presented before the Engineers Society of Western Pennsylvania, November 13, 1940. It appears here in print for the first time.

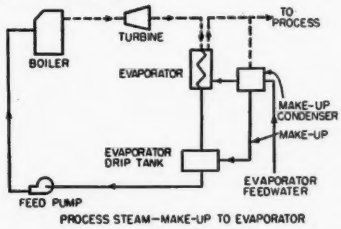


Fig. 1. Flow diagram in which an evaporator provides non-returnable steam for process

Feedwaters

The feedwater may consist almost wholly of condensate, contaminated but slightly by any inleakage of impure cooling water, and a small percentage of evaporated make-up. These conditions obtain particularly in the steam generating plants of the utilities, where little or no steam is used for process work from which it cannot be recovered as condensate. However, where considerable steam is required for process work, or for heating purposes, and cannot be returned as condensate, one of two procedures may be followed:

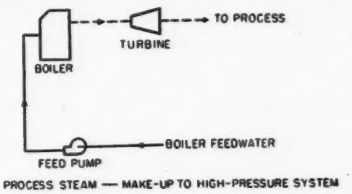


Fig. 2. Flow diagram in which process steam is taken directly from turbine

A. Steam at appropriate pressure and temperature may be bled from the turbine, condensed in passing through an evaporator, and returned, as condensate, to the high-pressure system. Meanwhile, the plant water, conditioned by

some one of the different processes available for treating raw water, is fed to an evaporator, providing the nonreturnable steam for process work. (Fig. 1.)

B. Steam taken directly from the steam lines or bled from the turbine with appropriate desuperheating and pressure-reduction as required, is used directly in process work, and the feedwater to the boiler, in part or in its entirety, is filtered or treated water. (Fig. 2.)

Thus, the feedwater may vary from 1 or less p.p.m. to literally hundreds of parts per million of dissolved solids, and be characterized by varying degrees of hardness and widely ranging content of sulphate, chloride, silica, alkalinity, and other constituents.

Conditioning of Boiler Water

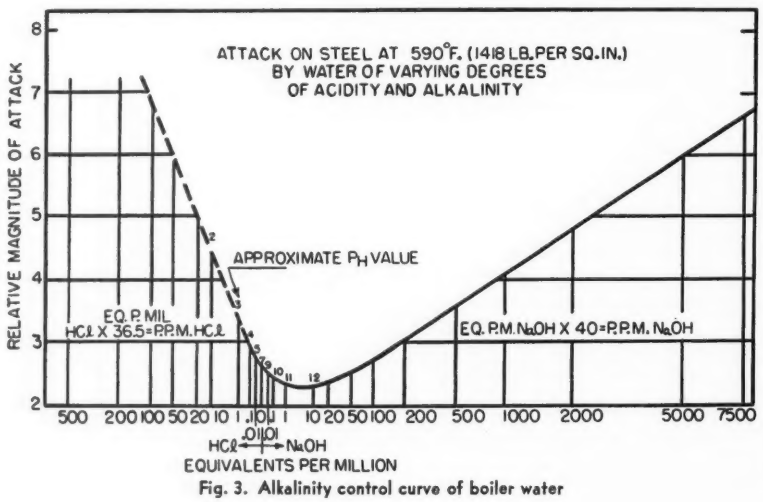
Experience and research have defined the essential characteristics of the boiler water. There are in reality only two general objectives which they must assure:

A. To establish and maintain unbroken a thin, nonreactive iron oxide film between steel and water which by separating them prevents any reactivity between them. The film is formed by the reaction of the metal and water, is integral with the metal, and its thickness is only that of a few wave lengths of light.

B. To prevent coverage of the surfaces by deposits derived from impurities in the water.

As the first step in realizing these objectives in the boiler water, preliminary preparation of the feedwater should be encompassed by filtration, softening, deaeration, or evaporation—in general, by those processes which economically and advantageously give facility and certainty to the job of keeping the boiler water right. For the purpose of this discussion, as many of these operations as the water may require are taken for granted as its normal preparation for boiler use.

The question might be raised as to whether there is a third possible objective in treatment of the boiler water aimed at control of carryover or foaming conditions. We believe not, for the following reasons. First, oil and other organic saponifiable material that will be provocative of foaming may best be dealt with by coagulation and filtration or by oil separators, thus effecting their removal from the feedwater and not permitting their entry into the boiler. If in spite of all effort directed at the feedwater, carryover of boiler water in the steam persists, the problem must be tackled from the standpoint of better controlled blowdown, baffle arrangements or steam washers in the steam drum of the boiler, steam separators, and very advantageously, when boilers of standard types must be driven at top ratings, by addition of circulating tubes to provide more ample capacity for delivering steam to, and thus promoting greater quiescence in, the steam drum. From the chemical side, some help may be gained by undertreatment and by use of sludge-dispersing reagents, but this is supplementary to the second general objective mentioned above. Second, and most important, however, addition of special anti-foaming reagents is on the whole a shot-in-the-arm proposition, and inapplicable in the carefully controlled procedure of any station pursuing regulated maintenance of conditions in the boiler water. Also, these reagents when subjected to conditions in the boiler water may saponify, or distill with the steam, and to be effective with any consistency may require that all alkalinity in the boiler water be neutralized. Such a method may find application under special conditions in railway locomotives, but certainly cannot be sanctioned in general. For these reasons it does not seem tenable to include this possible third objective in the general objectives of treating a boiler water.


ATTACK ON STEEL AT 590°F. (1418 LB. PER SQ. IN.)
BY WATER OF VARYING DEGREES
OF ACIDITY AND ALKALINITY
RELATIVE MAGNITUDE OF ATTACK
APPROXIMATE PH VALUE
EQ. P.M. MIL
HCℓ X 36.5 = P.P.M. HCℓ
EQ. P.M. NaOH X 40 = P.P.M. NaOH
500 200 100 50 20 10 1 .1 .01 1 10 20 50 100 200 500 1000 2000 5000 7500
HCℓ
NaOH
EQUIVALENTS PER MILLION
Fig. 3. Alkalinity control curve of boiler water

First General Objective—Maintenance of a Protective Film

One or both of two rather simple chemical reactions are responsible for formation of the protective film,

(1) $Fe+H_2O=FeO+H_2$

and (2) $3Fe+4H_2O=Fe_3O_4+4H_2$

The formation of the iron-oxide film is in nowise dependent upon oxygen dissolved in the boiler water, but represents tapping of the huge supply of oxygen held in the water itself (88.8 lb. of oxygen for every 100 lb. of boiler water). "As the volume occupied by the oxide is greater than that of the iron from which it is formed, it represents an impervious surface, and further attack of the metal must proceed by diffusion of the reactive agents through the film. If the metal surface is thus completely covered by an impervious oxide film, and immune from further attack, save by diffusion of gaseous water molecules inward, and hydrogen molecules outward through the film, any corrosion of the metal, and hence increase in thickness of the film, will be retarded greatly with each succeeding increment to the film."

Alkalinity Control Curve

The alkalinity or pH value of the boiler water is the best guide for determining when the film is being most completely maintained, and is being best protected from subversive influences which would engender its destruction. Proof hereof is found in the data of Berl and van Taack, who measured the attack of pure iron powder on water at the temperature of 590 deg. F. (1418 lb. per sq. in.) and over a considerable range of pH. From these data, interpreted in the light of operating experience, the

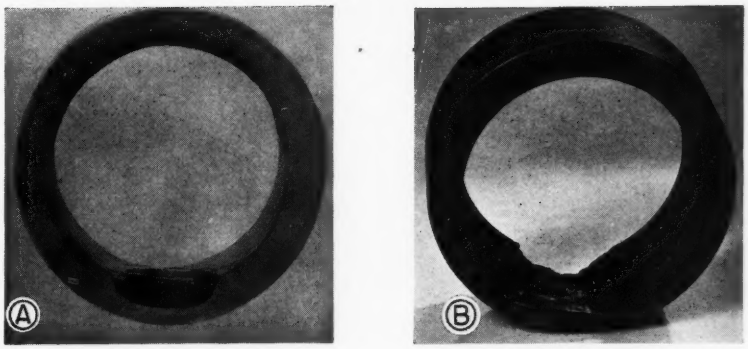


Fig. 4. Corrosion in generating tube. A. Corrosion product in place. B. Corrosion product removed

curve of Fig. 3 is obtained, which defines clearly the optimum pH to maintain in the boiler water. Relative magnitude of attack is plotted on the vertical axis, and acidity or alkalinity on the horizontal. The approximate pH values are denoted by the figures following the course of the curve. It is quite apparent that the relative magnitude of attack is least in the pH range of 11-12, or the corresponding content of caustic soda of from 40 to 400 p.p.m. On either side of this range the relative magnitude of attack increases. With decreasing pH value —that is, increasing acidity in the boiler water—the protective film dissolves thus:

$$FeO + 2HCl = FeCl_2 + H_2O$$

In the region of higher pH value—strongly alkaline boiler water—the film is dissolved by caustic soda thus:

$$FeO + 2HONa = Fe(ONa)_2 + H_2O$$

For the normal condition of ample circulation over the boiler surfaces, the pH range 11-12, corresponding to minimum attack, undoubtedly defines the most favorable concentration of alkalinity in the boiler water.

High Local Alkalinity

When rapid concentration of drops or films of normally alkaline boiler water produces high causticity in contact with the protective film on the tube surface, rapid dissolution thereof follows, and consequently paves the way for direct and rapid attack on the unprotected metal surfaces by the water. The result of this attack is found in the form of gouging and grooving, and at times in intercrystalline cracking similar to embrittlement. The attack may be slowed down by maintaining boiler water pH slightly to the left of the optimum 11-12 range of minimum attack (in extreme cases as low as 9.5-10), thus preventing development of high causticity, as concentration occurs. This procedure mitigates, but does not cure, the trouble. Cure lies in elimination of the causes of local high concentration of the boiler water, and thus becomes a problem of circulation.

Examples

1. Fig. 4, A and B, illustrates corrosion which occurred in one of the generating tubes of a high-pressure boiler. In A, the corrosion product, magnetic oxide (Fe_3O_4), remains in place just as it was found, and in B, has been largely dug out for examination. In the analysis of this case, the first question is, Was the oxygen content of the feedwater sufficient to be responsible for this attack? No; this plant is equipped for the complete deaeration which characterizes the most modern plants; besides, regular testing for oxygen by the most exact methods showed its presence only in negligible amount. Furthermore, in other plants, where similar corrosion has occurred, additional precaution against oxygen attack is taken by maintenance of an oxygen scavenger, sodium sulphite, in the boiler water.

What is the mechanism of formation? Where the pit advances into the metal under the plug of corrosion product, boiler water concentrates, and in doing so becomes highly alkaline.

The attendant result is dissolution of the protective film and consequent direct reaction of metal and water, thus driving the pit forward. How did the pit start? Probably in this case by accumulation of sludge over the metal surface, which in itself permitted concentration of boiler water to occur at the metal surface, thus establishing conditions for the development of this type of pit.

2. Nor is growth of pits in this manner something that is limited to modern high-pressure boilers. For instance, older boilers, characterized by bad pitting conditions because of uncontrolled amounts of oxygen in the feedwater, and not too great care given to maintenance of alkalinity in the boiler water, later may be operated with full attention given to deaeration, and to maintenance of alkalinity and oxygen scavengers. Yet those pits in which the corrosion product has formed a plug will continue advancing into the metal. Why not? The plug filling the pit permits the boiler water to seep in and concentrate locally, and thus the pit which started because of the presence of oxygen may now continue to grow because of high alkalinity at its interface with the plug.

3. Sometimes the cause is obviously steam blanketing. Examples in this category have been fully discussed by Partridge and Hall elsewhere.

Obviously, the remedy is to prevent high concentration of boiler water between the pit and the plug which fills it. Sometimes, it is enough to free the pit of its old deposit, whereupon circulation inhibits any concentration sufficient to destroy the protective film covering the metal. Sometimes, it is necessary to prevent sludge accumulation in particular areas. Sometimes, it is necessary to attack the problem from the standpoint of establishing more positive circulation of boiler water in the area in question.

In cases like these, distinguishing correctly between oxygen and high causticity as cause, saves both time and expense in relieving the condition.

Embrittlement

Embrittlement is a special case of the high alkalinity attack shown in the righthand rising section of the curve of Fig. 3. The attack occurs because of concentration either of normally or highly alkaline boiler water to give high causticity in narrow seams, as where tubes are rolled in, and in the older boilers, around rivets and butt straps. The high alkalinity rapidly destroys the protective

film. The possibilities of protection lie either in sealing the seams, or in chemical treatment to forestall the destruction of the protective film by the high causticity. A review of the extensive work done by Straub and by Schroeder, Berk, and O'Brien, or the summary prepared by Partridge, acquaints one with a variety of chemical substances which under one set of conditions or another have proved efficacious in protection. These run the gamut from staid, common, inorganic substances, such as sodium sulphate, chloride, phosphate, chromate, sulphite, and nitrate, to complex organic substances of the tannin and lignin type. Iron oxide and sodium aluminate have been credited with protective action; other oxides, as silica and lead oxide have been found to accelerate embrittling action. Despite the wide range of experimental work that has been done, not one of these treatments can be definitely guaranteed by its sponsor to provide protection for all conditions, or even for any one particular set of conditions. They seem protective in one test, and in the next, bog down.

As Walker has pointed out: "Caustic embrittlement requires the simultaneous occurrence of three conditions: (a) certain chemical conditions in the boiler water; (b) physical conditions which permit high concentrations of the dissolved solids; (c) contact of the concentrated solution with highly stressed boiler metal."

No one—owner, manufacturer, operator, consultant—can foretell whether any or all of these conditions obtain in any boiler in question. What concerns operator and owner is to be certain that the three factors never simultaneously exist. If he can so establish conditions that beyond peradventure merely one of these factors is suppressed, he can rest assured of his protection against embrittlement.

The one factor that he can control with certainty is treatment of the boiler water to render it non-embrittling in character. Despite the extensive experimentation of the past decade, and the comprehensive survey of conditions in the field, as reported by Rice, there are no general rules by which the result of certainty can be effected. However, this state of affairs has been clarified in a neat manner, which to the writer seems the biggest advance yet made in effecting protection from embrittlement. Independently, Straub, on the one hand, and Schroeder, Berk, and O'Brien, on the other, have developed equipment in which the test piece definitely embraces conditions (b) and (c), as set forth by Walker. When the test is run, therefore, if the water is embrittling, the test strip will crack; if the water is non-embrittling, it will not crack. The test is fundamental in nature, and thereby a criterion is established which enables each operator to discover by trial what treatment of his boiler water is requisite to render it non-embrittling. With this accomplished, the simultaneous existence of the three factors, which is requisite for embrittling action, is debarred, and definite protection acquired. Two valuable objectives have thus been accomplished:

1. The whole subject of intercrystalline attack has emerged from a nebulous, to a fairly definite and easily comprehensible state;

2. Protection advances from the status of vague hope to that of realizable fact.

Our work follows Schroeder's procedure*, because the testing equipment is attached directly to the boiler under observation, and the regular boiler water flows through the equipment continuously. Thus, a test may run for 30 days or 60 days as desired, and integrate the total effect on the specimen of the boiler water and any changes occurring therein over that period. In this manner, right in the plant, the operator follows his treatment of the boiler water and the result from an embrittling standpoint, finally arriving at those conditions which assure him with certainty that the boiler water is non-embrittling; that the simultaneous existence of the three conditions necessary for embrittlement can never occur; and therefore that he has given his plant the maximum protection from trouble of the sort.

Low Alkalinity or Acidity

To the left of the optimum pH range of 11-12, as shown in Fig. 3, is the region of low alkalinity or even acidity, which is characterized by increasing ease of demolition of the protective film. Troubles of grooving or thinning of tubes may develop under these conditions; or at times, fatigue cracking may develop. Corrosion by dissolved oxygen is more pronounced. Avoidance of such difficulties traceable to low alkalinity of the boiler water means merely to schedule maintenance therein of a protective higher pH value.

*This was described by Schroeder, Berk and Stoddard in the August, 1941, issue of Power Plant Engineering.

Dissolved Oxygen

Dissolved oxygen in the boiler water causes pitting, being destructive to the protective film in the following manner: In contact with the boiler water, the film dissolves slightly, forming $Fe(OH)_2$. When this contacts dissolved oxygen, the reaction is one or both of the following:

$$2Fe(OH)_2 + \tfrac{1}{2}O_2 = Fe_2O_3 + 2H_2O$$

$$3Fe(OH)_2 + \tfrac{1}{2}O_2 = Fe_3O_4 + 3H_2O$$

Why is the action selective in pits rather than evenly distributed over the surface? Presumably, because both metal and protective film are not uniform, and thus are more reactive at some points than at others. Or, for that matter, temperature differences, or slight obstructions to even flow over the surfaces, may have a bearing. In any case, dissolving of the protective film proceeds at greater speed to produce more $Fe(OH)_2$ in solution, as the dissolved oxygen reacts with it and removes it as the ferric or magnetic oxide.

To frustrate the action of dissolved oxygen, two procedures are apparent: (1) to maintain in the boiler water that pH value of 11-12 which results in minimum dissolving of the film, and thus minimum $Fe(OH)_2$ subject to reaction with any oxygen; and (2) to assure minimum dissolved oxygen by as complete deaeration as possible of the feedwater before it enters the boiler, and by maintenance in the boiler water of oxygen scavengers such as sodium sulphite or tannin.

(To be continued.)

ALTHOUGH many companies are having difficulty in meeting defense and non-defense demands for goods, especially durable goods, and are curtailing non-defense production because of limited supply of materials, effect on employment has been small, since available facilities and workers have largely been turned to defense work. It is thought, however, that curtailment of civilian goods manufacture, especially where aluminum, zinc or nickel is involved, will increase in the next 60 days since consumer demand is rising due in part to expanding payrolls and in part to fear of future shortage of goods.

Rope Replacement Cost Cut in Half

Threefold increase in service of ropes on coal-handling bucket crane accomplished by use of preformed ropes

BY F. L. SPANGLER

Wire rope in coal handling service about power plants is subject to severe wear due to dust and weather conditions

SEVERE WEAR in the holding and the closing ropes of bucket cranes generally takes the form of fatigue breaks in the outer wires. In an effort to improve rope service in this type of installation, one user of a large coal-handling bucket crane has kept accurate records of rope life over a period of many years. In this particular installation, ropes of 6 by 21 filler wire, regular lay construction, with hemp centers, have always been used as holding and closing lines. Originally these ropes were of non-preformed construction and required frequent replacement, the maximum service from the closing line being only 53,000 t., and from the hoisting line 58,000 t.

Service with Preformed Rope

In 1937, preformed rope was substituted for both lines, and the tonnage obtained from these ropes was about trebled and the cost of rope replacement reduced more than half. In the more than 4 yr. that preformed ropes have been used, the closing line has been replaced only 36 times and the holding line only 33 times. The maximum tonnage obtained from a preformed holding line to date is 188,000 with an average tonnage of about 155,000. The maximum tonnage from a preformed closing line is 163,000, with an average of about 142,000.

The decision to try preformed rope came about through the satisfactory performance of this type of rope on another piece of equipment on which non-preformed ropes had the exasperating habit of jumping off the fairlead sheave, resulting in severe damage that greatly shortened their life and sometimes required their immediate replacement. Since the day that preformed rope was substituted, no trouble of this kind has been experienced, and it was found that the preformed rope spooled more evenly, resulting in less rope abuse on the drum. The much longer life obtained from preformed rope on this application has been duplicated in the case of the crane ropes.

Deterioration on the holding line of the coal-handling crane is greatest at the guide rollers. Since these rollers are only 4 in. in diameter, they produce high bending stresses in the rope, thereby promoting fatigue. When this rope reaches the half-way point in its service life, it is turned end for end, thereby bringing the wear points to other parts of the rope and eliminating the need for early replacement.

Preforming Reduces Fatigue

Greatly increased life of preformed rope in crane application is attributed to the high resistance of preformed rope to fatigue. The individual wires and strands of preformed rope are preshaped before the final manufacturing operation so that they lie naturally in their final helical shape. Thus there is no unbalanced stresses in the wires which tend to cause unseized ends to broom out and unlay, and this absence of locked-up stressed results in a reduced total stress in the rope as it operates over sheaves and drums. Since the fatigue caused by an alternating stress is greater the higher the total stress in the wire, any method that reduces stresses, such as preforming the wires and strands, results in slowing up the action of fatigue. When fatigue does occur, it makes its appearance in the form of breaks in the crown, or outside, wires of the rope.

The racking line used on the coal-handling crane consists of ¾ in. rope of Warrington construction, regular lay. This rope is not subjected to the high bending stresses and high loads that cause deterioration of the holding and closing lines, and therefore fatigue is not an important factor in its replacement. Hence, non-preformed rope is used, replacement being made about once a year.

Service Records Reveal Weaknesses

Any sincere attempt to reduce rope replacement costs should take into consideration the kind of rope being used. Careful service records of various types of rope will reveal which is the most economical, and it might be found, as in the case of the coal-handling bucket crane, that a change in the type of rope will greatly reduce replacement costs.

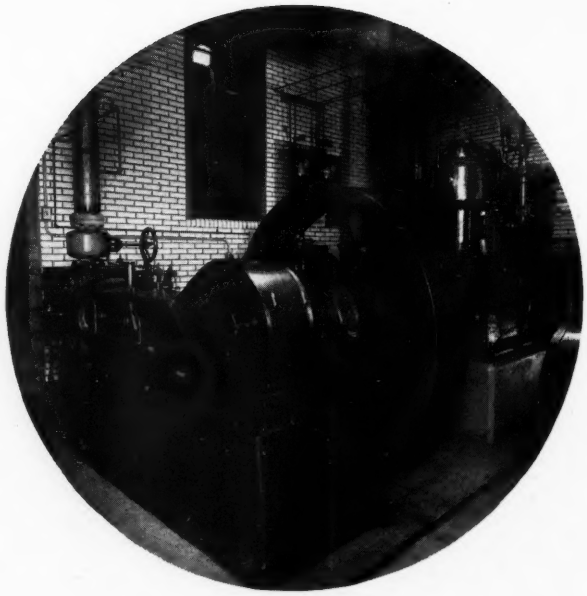


Fig. 1. One of the old Elliott four valve non-releasing Corliss engines, rebuilt and placed in operation driving an ammonia compresser

A RUSH JOB OF REVAMPING UTILITIES*

The Administrators of the Robert Koch Hospital were up against it. With a large rehabilitation program planned P.W.A. suddenly announced a time limit terminating all public works operations. What to do! So they went to work in earnest and finished the entire job in a year. In this article Mr. Pugh presents an account of the project

BY E. C. PUGH
Mechanical Engineer, City of St. Louis, Mo.

IN 1854, the City of St. Louis purchased for $5000 a 45-acre tract of land about 15 mi. south of the City on the west bank of the Mississippi River, as the site of a quarantine station. A two-story stone house, dating back to 1800, was used as a residence for the steward, and a number of small frame 20-bed houses were built. Since Jefferson Barracks, adjoining the property on the north, one of the first outposts in early American frontier history, and was a very active army base during the Civil War.

In 1908, the present administration building and original boiler house were built, one-story frame and stucco patient buildings were erected, and in 1910 all tuberculosis patients of St. Louis were transferred to this institution, which was now called Robert Koch Hospital. A nurses' home was added and in 1916 a schoolhouse for children. In 1920, a Tuberculosis Controller was appointed and a building program started. An additional tract of 115 acres was purchased, and by 1926 two patient ward buildings, an employes' dormitory, additional boiler house, laundry, dining room and a kitchen building were erected. In 1932, other contagious disease patients having been removed, the institution, with a bed capacity of 234, was used for the first time exclusively for tuberculosis patients. Soon the hospital's capacity was taxed to the limit and 140 patients were cared for in other City hospitals. There was a waiting list.

In 1933, with a bond issue of $1,500,000 and a P.W.A. grant, a new extensive building program was started. Two new patient buildings were erected, adding 324 more beds. An addition was made to the employes' dormitories. The new building program further included the erection of two more patient buildings, thus closing up a quadrangle and making a total bed capacity of 882. Also included were new kitchen and dining room facilities and a new boiler house, power plant, refrigeration plant and laundry. A new administration building, doctors' quarters and nurses' home were also contemplated.

Quick Work Required

At this time P.W.A. announced the time set for terminating all public works operations. St. Louis did not have time to complete the entire proposed program. The situation was serious. The institution had increased its population more than 100 per cent, but the power, light, heating, hot water, refrigeration, and laundry plants had not been touched. They were completely overloaded, old age and negligence had taken their toll, and the equipment was in no condition whatsoever to handle the institution needs. Yet the hospital must carry on. Could these plants be rehabilitated within the time limit?

The boiler plant included two 300-hp. and one 500-hp. water-tube

*Presented here by courtesy of the Elliott Co. and appearing simultaneously in the Fall issue of "Powerfax."

boilers with chain grates. Fuel storage was in bins in front of the boilers and handled from bins to hoppers by scoops. Auxiliaries consisted of two old boiler-feed pumps, a feedwater heater and a surge tank. Piping was in deplorable condition and everything "hay wired" together. No combustion control, no automatic equipment of any kind. The old building walls had cracks in them. The wood roof was just over the tops of the boilers. The breeching extended above this roof. What light and ventilation there was came in through small windows high up in the walls and through the door when it was open.

Fig. 2. The new power plant. At the left is the engine room; in the center the boiler house and at the extreme right the one-story building is the new laundry.

The power plant, consisting of a 75-kw. and a 125-kw. direct-current engine-generator, had grey hair too. The switchboard used the old open knife type fused switches.

The refrigeration plant had a capacity of 35 tons. The ice field, of 7½ ton capacity, was manufacturing 50 lb. cakes of ice. There was an engine-driven and a motor-driven ammonia compressor. Also a steam-driven and a motor-driven brine pump (but the motor had "passed on" some time before). Condensing coils consisted of a wall bank of pipe coils. The cooling water recirculating pump, like the motor, had passed out and raw tap water was used and wasted to the sewer.

There was a pipe tunnel extending from the power house through the center of the campus quadrangle to the Administration Building, a distance of 1000 ft. In this tunnel were all service lines, including steam and hot water supply and returns, electric and refrigeration brine lines. The brine lines leaked at every joint. With all the buckets hanging everywhere, it looked like a Vermont sugar maple grove in early spring.

The laundry had long outlived its usefulness and was just getting along.

This was the gruesome picture facing the City. There were rays of sunshine, however. Contracts had been let to build a new power plant room and install new alternating current engine-generators, and a main switchboard, a new power and lighting distribution system, including four substations. The "change over" from direct-current to alternating-current throughout the institution was about ready to go on the market for bids. But nothing had been done about the boiler plant, refrigeration plant, laundry, or buildings for them.

This work had to be completed in a year, and it was. All contracts were let in December of 1939 and completed in November of 1940.

Keeping Utilities Going

The big problem was to erect and install these plants without interfering with normal operation of the hospital. The program was set up and carried out as follows:

The laundry was laid out and equipment purchased. The building was designed after production flow sheets had been established. This was the only separate building to be erected in this group. The machinery, all new, was scheduled to arrive after the building was under roof. The old laundry, in a portion of the original power house group, was operating while this work was going on.

The refrigeration plant presented another problem. It was to occupy the space housing the existing refrigeration plant and the two direct current engine-generators, with the new ice field in a portion of the space occupied by the old laundry. A heating return line vacuum pump was to be installed in a new grating-covered pit where the motor-driven ammonia condenser was located. A new brine supply and return line system throughout the institution had to be installed complete. This work had to be done while the laundry, the refrigeration plant, and direct current generators remained in operation. The refrigeration contractors ran brine lines paralleling old lines, leaving openings for quick connections to refrigerated rooms and equipment. These pipes were covered, cut into the old brine pump, connections made to the refrigerated equipment and the new distributing piping was in operation off old equipment. In the meantime, laundry equipment was moved and the ice field and ice storage rooms were constructed. The wall stand of ammonia condensing coils was set up outside the building. It was not necessary to run cooling water to them. It was winter. The old compressor was removed and the new ammonia condensing equipment and air compressor installed. The refrigeration system was operating off the old engine-driven compressor.

By this time, the new alternating current generating plant, substations, and distribution system were in operation. The old 125-kw. d.c. engine-generator was removed, leaving the 75-kw. unit to serve the boiler house and laundry, and the rest of the institution was thrown over to alternating current.

This permitted setting up the new motor-driven ammonia compressor in the location vacated by the 125-kw. unit. The compressor was connected into the new refrigeration system. This made available the old engine-driven compressors, which was overhauled, the engine rebored and put in good condition to move into its final position, that

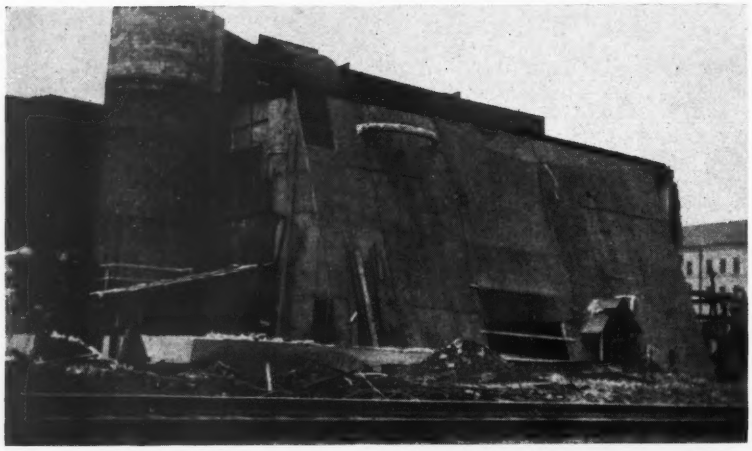


Fig. 3. A construction picture showing the lean-to which enabled the boilers to be operated during the construction program. The operators had to come outside the lean-to to read the gage g'ass and pressure gage on the old 500-hp. boiler

formerly occupied by the 75-kw. d.c. generator.

By this time, the new laundry was ready for operation. The original laundry was vacated, a new roof installed, a water cooling tower located on the roof, a new floor laid, and the interior partitioned off into shops. New heating and lighting facilities were installed.

While this was going on, changes in the boiler house were started. One of the old 300-hp. boilers was to be replaced with a new 500-hp. unit, all old auxiliaries and piping of every kind were to be replaced. Overhead coal storage bunkers with auxiliary elevators and conveyors, and new induced-draft fans for the two 500-hp. boilers were to be installed. All stoker drives were to be renewed with dual steam and motor drives. A complete combustion control system, a water softener plant, heaters, pumps and a new hot-water service system were to be installed.

The building alterations necessitated doubling the height of the front walls and a portiton of the side walls, the remaining walls to be raised about 10 ft. to a new roof level. Three sides of the old buildings were to be torn down, new foundations formed, and the walls rebuilt to the new heights. Heavy-section steel columns had to be erected to carry the overhead coal bunkers, and it was found necessary to go 40 ft. below the surface through quicksand to reach bed rock. While doing this, the old boilers had to operate 24 hr. a day.

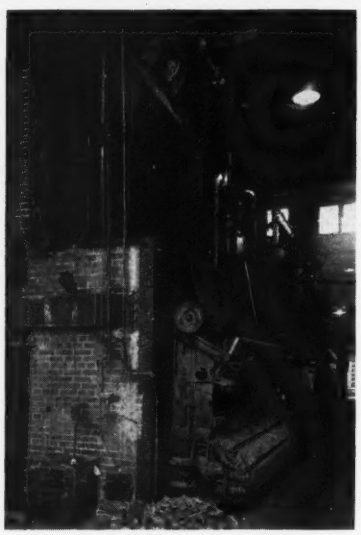


Fig. 4. The old boiler room. The middle boiler, 300-hp., was removed and replaced with a new 500-hp. boiler. The other two boilers were entirely reconditioned

The general contractor cut the old roof off at the front of the boilers, supporting the roof on temporary structures. He then removed front and side walls, built a temporary lean-to of plyboard leaving open the portion in front of the boiler which was to be replaced, and covering the opening with a tarpaulin. This made the space to be occupied by the cold storage bunkers, and mezzanine floors carrying the feedwater heaters, surge tanks, and hot-water generators free for construction operations.

The old boiler and stoker (in center of bank of three boilers) were removed and relocated in a greenhouse. The contractor built his new foundation and erected his boiler with other trades sinking steel sheet piling 40 ft. into the ground just 18 in. from his foundations, with iron workers erecting steel columns on these piles and riveting steel coal bunkers overhead.

The fire-room gang had to haul all fuel in wheelbarrows from a coal bank along the railroads siding 100 yd. away. The lean-to gave them only 6 ft. of space in front of the boilers. Boiler-feed and hot-water circulating pumps were supported on cribbing over foundation excavations. Structural work was being fabricated overhead and frequently hot rivets would fall. No one was hurt; they carried on 24 hr. a day. It was winter, with temperatures below freezing, but the safety and comfort of 1500 people and several nervous engineers were de-

Fig. 5. The new boiler room. One new 500-hp. boiler was installed, the other two boilers were reconditioned and all new auxiliaries and piping installed. Automatic combustion control equipment was also installed

pending on that plant operating without a shutdown of over 8 hr. at any one time. The 500-hp. boiler was carrying the load. The old 300-hp. boiler was the standby.

The piping contractor had a carefully prearranged program. The original main header was kept and used as a standby with all distributing steam lines bypassed into it. The new header was erected, and the new boiler and all auxiliary steam and distribution lines were connected to it. By now, the mezzanine floors were in place and the feedwater heaters and pumps were installed and all connections made to the new boiler which had been completed and dried out under a slow fire. The new boiler was thrown on the line while it was still hand-fired, as coal handling equipment was not yet in operation.

The two old boilers were now connected into the new system. The coal-handling equipment was operating, the combustion control functioning, all stokers modernized. The plant was operating 100 per cent, although building operations were not complete. The boiler house was now thrown over on to alternating current, thus making the direct current to alternating current change-over of the institution complete. This permitted the removal of the old 75-kw. d.c. generator, allowing the refrigeration contractor to move and install the rebuilt engine-driven ammonia compressor, completing his contract.

In the space vacated by this compressor the water softening plant was installed and connected to the feedwater heaters and the laundry and institution hot-water service system. This completed the piping contract.

The general contractor in a very short time finished up, completing the program.

There were 16 major contractors on this work. They deserve great credit for their understanding, ingenuity, and "give and take" co-operation. Manufacturers produced material exactly as requested and needed. There was no hold-up anywhere. As a result, Koch Hospital now has a power plant and utility equipment equal to any plant of a similar size in the country.

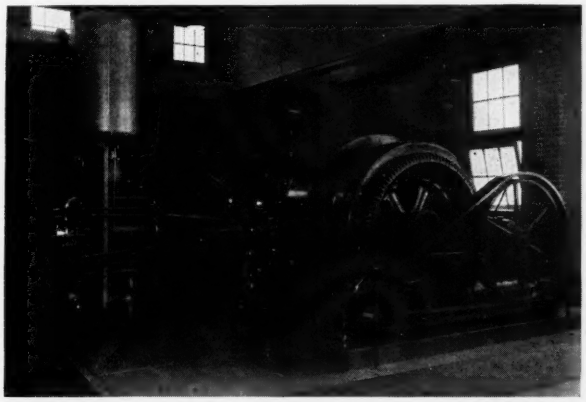


Fig. 6. (Above) The new engine room houses two Elliott 4-valve engine-alternator units, one 200-kv. and one 300-kv.

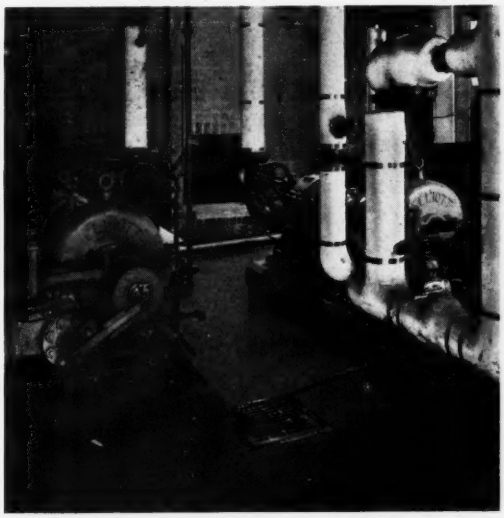


Fig. 7. (Right) The two new boiler feed pumps are turbine driven at 3550 r.p.m.

The New Plant

The new laundry brings contaminated wash in at one end and passes it out clean at the other end. The very latest types of laundry equipment were used. The equipment will put out 40,000 lb. of laundry a week, which capacity will handle all contemplated institutional expansion.

The new power plant consists of two engine-generators, 200-kw. and 300-kw., 4-valve Corliss engines driving 2300-v. alternators. The building, commodious, well lighted and ventilated, is designed to accommodate an additional 400-kw. unit.

The new 70-ton refrigeration plant consists of a motor-driven and an engine-driven compressor, which can be run separately or in parallel. Shell condensers with brine circulating pumps and a 35-ton ice field manufacturing 300 lb. cakes complete the plant. An atmospheric deck cooling tower provides cooling water for the condensers. This plant has sufficient capacity to service the contempated future expansion.

The boiler plant now consists of one new and two thoroughly reconditioned boilers, with stokers and combustion control. The two 500-hp. boilers are equipped with forced draft, the 300-hp. boiler has natural draft. Auxiliary equipment includes two steam turbine-driven boiler-feed pumps. There are two vertical deaerating feedwater heaters, each having a capacity of 50,000 lb. per hr. Steam to these heaters is from the 5 lb. low-pressure system, water supply from two surge tanks at a temperature of 125 to 170 deg. F. Average make-up water is about 15 per cent of the total rated capacity of the heaters. Surge tanks, heaters and pumps are so piped that they can be run as individual units or in parallel.

The coal-handling system consists of a track hopper on a railroad spur, apron conveyor, bucket elevator which discharges into a belt conveyor with a movable tripper to discharge coal in a predetermined bunker. The 450-ton bunkers are equipped with valves and the coal is discharged into stoker hoppers through a weigh larry and spout. Space is reserved for a coal crusher, but as coal is now purchased in cars, properly processed, this equipment is omitted for the present.

The institution is supplied with raw City water through two 6-in. mains, and a motor-driven booster

pump in the boiler house pumps this water to a tower for house service. This pump has an automatic starter controlled from a water level in the tower. The water softening plant consists of a complete Zeolite down-flow system. The hot-water recirculating system consists of two combined instantaneous heaters and storage tanks, the circulation provided with three motor-driven circulating pumps, supplied with automatic starting equipment. The heating system is provided with a duplex vacuum return line pump and receiver.

All equipment and material selected and installed on this project was of the best, and while time was essential, workmanship was of the highest grade. The City of St. Louis got a good job in every respect. The cost of the program is broken down as follows:

Laundry building and equipment	$ 91,000
Refrigeration plant	43,000
Power plant building and equipment	68,000
A.c. to d.c. change-over	62,000
Boiler plant building and equipment	228,500
Total	$492,500

Use was made of existing buildings and equipment which can be credited as considerable saving to the City. Though it might have been easier to have designed new buildings and equipment throughout, it would have disarranged the architectural scheme, the old equipment would have had to remain in operation until the new work was completed and then torn down, cut over into the various existing lines from the new equipment, and the cost would have been much higher. As it was, everything worked out beautifully, everyone is happy and it was much more fun doing it this way.

This program was carried out under the direction of Mayor Bernard F. Dickman, Joseph M. Darst, Director of Public Welfare; Dr. R. L. Thompson, Hospital Commissioner; Dr. George L. Kettlekamp, Superintendent of Koch Hospital; Baxter L. Brown, President Board of Public Service; Wm. C. E. Becker, Division Engineer, Bridges and Building Sections; Walter R. Crecelius, Assistant Division Engineer; Albert Osburg, Architect; and Earl C. Pugh, Mechanical Engineer.

Internal Combustion Engine Casualty Experience

Summary of an insurance company's report shows steady improvement in engine operation with bearing difficulties the most common cause of accidents

BY H. J. VANDER EB*

OF THE 413 accidental breakdowns in 3 yr. experience covering approximately 1450 engine-years, the Hartford Steam Boiler Inspection and Insurance Co. reports that 65 were on gas and gasoline engines, 167 on two-stroke-cycle oil engines, and 181 on four-stroke-cycle oil engines. The total amount of losses in these accidental breakdowns was $142,400.

Summarized in Table I is an analysis by type of accident with respect to the "initial part broken or damaged." In the summation of the "initial part broken", the actual number of such parts involved in each accident was not used. Instead of this, the numbers of the various items are the number of accidental-breakdown cases in which the "initial part broken" was the principal source of the trouble. For instance, the number opposite "main bearing" is the number of cases where one or more main bearings failed.

There has been a gradual improvement in the accident frequency during the last several years. It will be noted from the totals in Table I that the number of accidents decreased from year to year.

Table II gives the accident frequencies for 10 yr. The figures in this table, such as 1:2.3, mean that there was one accidental breakdown for each 2.3 engines during the year.

As a comparison, it may be stated that for steam engines the accident frequency is about 1:11.

An accident to an internal-combustion engine is defined in the insurance policy as follows:

Table I—Analysis of Internal-Combustion-Engine Accidents

Initial part broken or damaged	1938	1939	1940	Total	% of Total
Crankshaft	5	4	0	9	2.2
Main bearing	9	6	6	21	5.1
Crankbearing	25	21	24	70	16.9
Wristpin bearing	16	9	12	37	9.
Bearing cases combined	50	36	42	128	31.
Cylinder head	30	14	14	58	14.
Cylinder liner	1	5	5	11	2.7
Cylinder & cylinder block	9	4	8	21	5.1
Piston & piston rings	14	26	18	58	14.
Exhaust manifold	5	3	3	11	2.7
Fuel pump & spray nozzles	0	11	11	22	5.4
Lub. oil pump & piping	3	5	6	14	3.4
Connecting rod & crankbolts	3	2	3	8	1.9
Governor	4	8	5	17	4.1
Miscellaneous	21	19	16	56	13.5
TOTALS	145	137	131	413	

Table II—Accident Frequencies Among Internal-Combustion Engines

1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
1:2.0	1:1.5	1:1.4	1:1.7	1:2.3	1:2.3	1:2.5	1:2.7	1:3.1	1:3.5

*Assistant Chief Engineer, Turbine and Engine Division, The Hartford Steam Boiler Inspection and Insurance Co. Presented at the Oil and Gas Power Division meeting in Kansas City, Mo., of the A.S.M.E.

"Accident shall mean a sudden and accidental breaking, deforming, burning out, or rupturing of the object or any part thereof, which manifests itself at the time of its occurrence by immediately preventing continued operation or by immediately impairing the functions of the object and which necessitates repair or replacement before its operation can be resumed or its functions restored, but the breaking, deforming, burning or rupturing of any exhaust valve, valve spring, gasket, or gland packing shall not constitute an accident, nor shall the depletion of material in any part of the object, due to pitting, corrosion, or wear, be construed as an accident."

From this definition it will be noted that any sudden breakdowns of the engine or its parts (with minor exceptions) are covered by insurance. It is not the intention to cover defects that are found by inspection, such as slow progressive cracks, although the affected part might, at that time or later, need replacement or any troubles that are clearly of a maintenance character.

Referring to Table I, the crankshaft breakdown cases are 2.2 per cent of the total number of accidents. This is quite favorable as compared with previous experience. During 1940 not a single crankshaft case occurred which is a record. This favorable crankshaft experience is, undoubtedly, to a large extent, the result of painstaking inspection by means of a strain gage.

The bearing troubles, 31 per cent of the total, run fairly true to previous experience. For many years, the bearing-failure accidents in internal-combustion engines have roughly amounted to one in every three accidents. Practically, no improvement can be reported. The principal causes of bearing failures were improper attention to the lubricating systems and unduly rapid sludging of the oil. Overloading also appears to have been a considerable factor in the bearing failures. More than half of the bearing failures were on crank bearings.

The cases of cylinder heads, cylinders, cylinder liners, combined amounted to 21.8 per cent of the total. This is a somewhat lower ratio than it has been formerly. The last previous survey showed 24.3 per cent for the combined cases of cylinder heads, cylinders, and cylinder liners. Also the piston cases, 14 per cent, are fewer as compared with previous accident surveys. The fuel-pump and spray-nozzle cases, 5.4 per cent, are slightly higher than formerly.

The connecting-rod and crankbolt accidents, 1.9 per cent, are well below previous averages. In miscellaneous accidents, 13.5 per cent of the total, are included camshafts, gears, rocker arms, valves, flywheels, clutches, water pumps, and also such parts as give trouble very rarely.

A careful review of all the experience has clearly brought out the advantages of the dual-circuit type of closed cooling system as compared with the various types of open cooling systems. A much lower premium is charged (about 40 per cent less) for insuring engines with closed systems than for engines with open cooling systems. These lower premium rates have been in use for 5 yr. and the result has been that the ratio between numbers of insured engines with closed systems and those with open systems has changed, during the last 3 yr. alone, from 50-50 to 65-35. This change to closed systems has been a big factor in the improved accidental - breakdown experience.

REFRIGERATING ENGINEER

Part VIII. You learn by the hard way that just any kind of oil will not lubricate an ammonia compressor. You also learn that a refrigerating engineer must sometimes desert a very, very pleasant situation for an unpleasant one, and all because the oil you put into the compressor crankcase gummed up the works

BY GEORGE HOLMAN

ON YOUR way home you stop in at Doc Mender's office. The doctor removes the oil-covered bandage from your nose, and renews the one atop your head. He puts a neat little patch over the cut on your forehead and paints your skinned shin with iodine. "This is your second trip this week," he comments. "Have you had another automobile accident?"

"I haven't even had a first."

"You haven't? Are you a boxer?"

"No. I'm a refrigerating engineer," you answer, not quite lying, but stretching the truth quite a bit.

"I understand your injuries now," the doctor smiles. "A case of the proverbial wrench slipping. Or, do refrigerating engineers use wrenches?"

"You bet! And just about everything else, excepting their heads."

In spite of your injuries and a hard day at the plant behind you, you roll the old gas buggy out of the garage and wash it thoroughly. You wish fervently that the model were 5 yr. younger.

You get your best suit from the cleaners, borrow five dollars from your next door neighbor and hop into your car. You are going to fill that date with June Frost regardless of cuts, burns, bruises, skinned shins, blisters, aches, pains and bandages.

And fill your date you do, until it is interrupted shortly after midnight. At that particular time you are sitting in your car in front of the Coldfax home, with June's blond locks resting just under your right jaw. You are as close to heaven as you ever expect to get, when the silence of the night is interrupted by an intruder. A man comes rapidly down the street, starts to turn up the walk, then turns back to look curiously at your car. You cringe down in your seat a little, and hope that the man will pass on without recognizing you. But he doesn't pass on. The man is Allen Knowles.

Time's Up

Allen blinks a few times, then comes over to the side of the car. "I thought I recognized this old rattletrap," he says, while the light shining on his grin makes it diabolic. "Well, well! I guess being a refrigerating engineer isn't so bad after all!"

"Oh, it's not a bad job," you confess, then ask, "What brings you into this part of town at this time of night? It has been more than an hour since Andy relieved you. I thought you always went straight home and to bed."

"I just left the plant a few minutes ago," Allen says. "I've been trying all evening to contact you or Frosty. The cooling room compressor is all jimmied up. She started breathing kind of funny right after you left. Then she got to dragging. Chances are that the coils have defrosted."

"Daddy is away on business. He won't be home until tomorrow —until this afternoon," June volunteers, looking at her wrist watch.

"I'll have to go down to the plant and see what I can do," you regretfully tell June. But instead of stepping on the starter, you get out and accompany June up the walk. As soon as she unlocks the door, you step inside with her for a more private and also more pleasant goodnight. Then you go back to the car.

"Well!" Allen chuckles, as you climb into the machine. "You're here at last! I thought when you went in that you were going to take all night. I'm going to look into this refrigerating business a little deeper myself!"

You grin, for you have trouble putting memories of a wonderful evening out of your head and trying to concentrate on what has happened to the compressor.

It's the Oil

At the Wholesome, Andy comes out to meet you. "I think it's the oil. The oil gage glass looks gummed up on the inside."

And so it looks to you. You have been suspecting the oil, anyhow. You go to the supply locker, and look at the can you got the oil out of. Finding your book on refrigeration still in the window, you look up the reactions of ammonia with oils. "With animal or vegetable oils, or with compound oil containing animal or vegetable oil, ammonia, being a strong alkali similar to lye or washing soda, will combine causing such oils to saponify. Use only a pure mineral oil in ammonia compressors."

Part of the label on the can has been torn off and the rest of it is dirty. So is the oil in the can. You should have examined the oil before putting it into the machine.

Before putting clean oil into the compressor it must be cleaned out. Yesterday you learned that the crankcase had something else in it besides oil. Ammonia gas. That must be taken out. Maybe you can pump it out. You close the suction valve and try to start the compressor. The motor just growls—and the relay goes out.

What to do now? You open the switch, close the discharge valve, see that the pumpout and bypass valves are firmly seated, then start to loosen the nuts on the crankcase cover plate. Ammonia gas blows out. You let it blow for a minute. You tighten the nuts back into position, light a sulphur candle Andy has dug up somewhere and get outside, where Allen and Andy have already gone. You take the gas mask with you, just in case.

Brimstone? No, Thanks

After about five minutes you go back inside. A dense white fog fills the room. You can hardly make out the figures on the gages, even though the room is lighted by a half dozen 100-watt bulbs. But for once you can smell no ammonia. Besides the fog there is the unmistakable dynamic odor of burning sulphur—of sulphur dioxide, an acid gas which is even worse than ammonia to breathe. Deciding that you would rather have the disease than the cure, you take up the candle and set it outside.

You look at the compressor and at the suction gage. The crankcase and cylinders combined will hold 5 or 6 cu. ft. of ammonia gas, and at a pressure of 50 lb. gage. The space above the safety heads will hold only about 1 cu. ft. of gas. If you must take off the cylinder heads, you will have to add that amount of gas, which is at a 190 lb. gage, to that from the crankcase. Reduced to atmospheric pressure, the whole will amount to 40 or 50 cu. ft. of ammonia gas, when 1 or 2 cu. ft. would make the air of the room unfit to work in, unless you wear the mask. And it is hard to work in.

Water! Like a flash the bright idea almost floors you. You get an empty 5 gal. oil can with the top cut out and fill it above the halfway mark with cold water. You set the can on the floor beside the compressor, stick the oil charging hose into it as if to fill the crankcase with oil and open the charging valve. A deep sputtering commences in the can, and the vibration sets up ripples from the walls. Then the water begins to tumble over and over. The water level, covered by a scum of oily substance from the crankcase, rises slowly but perceptibly. Placing your hand on the outside of the can, you find that it has risen in temperature. Heat is evidently being liberated by the union of water with ammonia.

Soon the sputtering in the can dies down, and the water level ceases to rise. To make sure that you have absorbed all the ammonia into the water, you leave the hose in the can for several minutes. But when you start to close the valve, you find less water in the can than you put into it at the start. That perturbs you. Downright puzzled and not a little scared, you open the crankcase. You draw back a little, all set to dash for the door, but there is very little gas in the machine. By the light of the bulb on the end of an extension cord you peer inside. The crank shaft, piston rods and inner walls of the crankcase are covered with a foamy, soapy substance quite evidently derived from the oil. The bottom of the crankcase is covered with a liquid on which, as in the can of water, some of the soapy substance floats. You stick a finger into the liquid. Water? Yes, water and ammonia. Aqua ammonia. Absorption of the ammonia by the water had left a vacuum in the crankcase. And the atmospheric pressure had forced the water up into the machine through the submerged end of the oil hose. Now the aqua is slowly running back into the can.

Heads Off the Compressor

Allen deserts you, and goes home to bed. With the casual assistance of Andy, you take the cylinder heads off the compressor. Here the state of affairs is worse than down in the crankcase. Under the high temperatures of the discharge gas the substance derived from the oil has become both waxy and gummy.

While Andy takes your car and goes to the nearest filling station for 5 gal. of gasoline, you dismantle the machine. While you are

at work you notice that the smell of ammonia keeps up. By lighting a sulphur taper you discover that the aqua in the oil can is giving off ammonia gas. You pour the aqua down the sewer, and soak up what remains of it in the crankcase in wiping rags. Throwing the rags outside, you get rid of the rest of the aqua.

But not of the ammonia gas. A sulphur taper shows you that there is gas blowing by one of the stop valve seats in the manifold. What to do about that? You study the problem, and at last compromise by letting the valve or valves leak. But you go outside and get the sulphur candle, which is still burning. You set it in the farthest corner of the room near the core pump.

Comes the Dawn

At 4 o'clock daylight steals in upon you. It finds you with everything off the compressor that can be gotten off, excepting only the crank shaft, the flywheel and the outboard bearing. You finally get the machine cleaned and shining like a new pin, and it starts going back together at 5 o'clock.

Oil. You look suspiciously at the can from which you put the oil into the crankcase yesterday, then reject it. You take up the can you emptied the aqua ammonia from and wash it out thoroughly with gasoline. You take it back to the barrel labeled "Refrigerating Compressor Oil" and fill the can. Before pouring the oil into the crankcase, you look at the oil gage glass. You have forgotten to clean it, thinking only of the moving parts of the machine. You take time out for that, and for putting new wicks into the feed for the oil lines to the cylinder walls. You find no wicks in reserve. But why not use cotton string? Let's see. Ammonia is a caustic. It will work on wool, but not on cotton. Until you can get wicks, cotton string will have to do.

Nothing to Worry About

At 7 o'clock Butch comes in. "Mine coolers, Apel," he protests, somewhat perturbed. "Dey are varm."

"This compressor has been down most of the night," you inform him. "But we'll have her going within another hour."

You oil the new gaskets with compressor oil and close the machine. For a minute you divide your attention between the machine and the pressure gages. The suction pressure is now 50 and the discharge nearly 200. The lower pressure should be admitted first, for then if you have a leak, less ammonia will blow out before you can get it stopped than if the pressure were higher. And if you have to blow the ammonia out into water, you will lose less of it, and possibly have less of it in the air.

You open the suction stop valve, then close it. You pass a wet slip of test paper around all joints and the new packing, and find a slight leak around one head and at the cap on the wick box. Had you turned the high pressure on first, these small leaks could have been major ones.

At 8 o'clock you open the discharge stop valve, close the switch, and with the suction stop valve still closed, start the compressor. The pressure in the crankcase drops almost immediately to the zero mark, then gradually falls below it. You slowly open the suction valve. But when frost forms on the manifold and the machine grows ominously silent, you close the valve quickly and stop the compressor. You go into the tank room and close the same stop valve on the liquid line that you closed the day you twisted the head off the flange screw in the storage room. You are sure that the coils have too much liquid in them, and intend to keep out more liquid until you are sure the coils can handle what they have.

Coming back from the valve, you stop and look at the level of the liquid in the receiver. The level is much lower than it was yesterday, the gage glass now showing liquid only 2 in. at the bottom.

He Had to Go

Andy looks at the gage glass too. "It's that solenoid stop valve letting the ammonia into the coils when the compressor couldn't pump any out. That must have gone on for hours. The accumulator will be full, as well as the coils. And there's 3 mi. of 1¼ in. pipe in those coils. It'll take you all day to pump it out. Well, good luck. I've gotta get some sleep."

Andy goes home, and leaves you with an Ohio River Valley flood of liquid ammonia. With the suction valve closed, you again start the compressor. As soon as the machine comes up to speed, you crack the suction valve a little, then slowly open it a full turn of the wheel. You wait awhile, then open it a quarter turn more. Click—click—click. You close the valve the quarter turn you just opened it, and pause, ready to throttle it still more if the heads start slamming. But the heads don't slam; and the clicking stops. But frost forms on the manifold.

You go into the tank room and look at the so-called indicator on the accumulator. It is only a ¾ in. heavy duty pipe 4 ft. long connected by right angled elbow flanges to the accumulator. It stands vertical about half the height of the vessel, into which it taps about 3 ft. from the bottom and 1 ft. from the top. It is now frosted lightly from top to bottom.

You wait until the suction pressure drops to 20 lb., then open the suction valve wide. Nothing happens. The machine takes the load very nicely. You go into the tank room. The frost line on the accumulator has dropped 6 in. and is now below the level of the gas return line to the compressor. You go over and open the stop valve and let the liquid flow into the thermo-expansion valves on its way to the cooling room coils. Ah, back to normal at last! You saunter back down the steps into the machine room where you complete the adjustment of valves to get the desired pressures.

Butch comes in with something on a tray. "I know you haff efferding vixed oop, Apel, py kolly!" he says. "I hear der pneumonia in der pipes zing. I haff here someding to eat. Vee keep in der storage most efferding eatable, but no pread or coffee."

Having gone without breakfast, you are hungry. You are also tired, sweaty, dirty, sore and above all, very sleepy. The return of the frost line to the indicator worries you. In the five preceding days neither the indicator on the cooling room accumulator nor the indicator on the sharp freezing accumulator has ever shown a frost line.

While looking at the accumulator, you notice a valve down near the bottom. The valve is on a line leading from the accumulator. The line goes no farther, though, and the valve is plugged on its atmospheric end. The pres-

ence of the valve puzzles you. You ought to know what it is for.

It's Oil Again

You get a wrench and take out the plug. Cautiously, with both hands on the wheel, you crack the valve slightly. There is a crackling and popping sound, a smell of ammonia, and you close the valve quickly. But that is not ammonia trickling from the open end of the valve. It is oil, dark brown oil, looking nothing at all like the clear fluid you charged into the compressor.

Now, what is that oil doing in the accumulator? What office, if any, does it perform? Is it supposed to be there? If not, how did it get there? Is that valve there to charge oil? If so, why isn't there a charging hose?

Suddenly you feel sure that no oil belongs in that accumulator, that somehow the oil has gotten where it is from the machines. Maybe that wrong kind of oil you put into the cooling room compressor carried over into the accumulator. Maybe the accumulator has so filled with oil that it is basically the cause of the flooding still showing by the frost line on the indicator.

You get one of the empty open top 5 gal. cans and screw a piece of pipe into the open end of the valve. You set the can under the open end of the piece of pipe and open the valve. Sludgy, chocolate-colored oil foams out. You hold your breath while the can fills, then shut the valve and head for the window to get away from the ammonia fumes.

As soon as the ammonia diffuses, you go back to the valve. Your can of foam has dwindled to 2 in. of oil in the bottom. You dip your forefinger into the oil, and rub some of it between the finger and your thumb. It is gritty, and certainly would not do to put into the compressors. It would probably ruin the bearings and score the cylinder walls.

Twelve gallons of oil you get from the accumulator. The last time you open the valve, a blue cone of vapor spurts out into the can. You close the valve and race for the window before trying to carry the can outside and plug the valve. For right then you get a nice whiff of ammonia through the cannister of your gas mask.

After awhile you pick up the can and carry it outside. As you set this last can of oil beside the other two at the loading platform, you notice little pools of liquid floating on the oil You are amazed. The oil must be heavier than water, for isn't that water floating on the oil? To find out whether or not the liquid is water, you stick a curious forefinger into one of the pools. Instantly you jerk the finger back. But the injury has been done. Your forefinger is frostbittten and has an alkali burn. The pools are of the liquid ammonia causing the frost line on the indicator, as the frost collecting on the outside of the can should have told you. In miniature, they are Frosty's pools of anhydrous ammonia.

You are still puzzled about it all when at two-thirty Allen comes in to relieve you.

(To be continued)

MAGNET COILS And Related Data

Part III. In this third and final section of this consideration of magnet coils, the author discusses the application of coils together with a few paragraphs on factory equipment. The latter is necessary only for production purposes, but the principles covered in these three sections apply equally to the manufacture of a single coil or a million

BY B. W. ERIKSON

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IN THE TWO foregoing parts[1] of this article the design and characteristics of magnet coils were presented. Now, in this third and final section we will discuss the problem of actually applying coils to certain purposes. This resolves itself into certain technical and practical considerations.

First, we must know, of course, the turn-voltage proportionality rule, outlined in the previous sections. Further we must know how to compensate for exceptional ambient conditions using the voltage squared (E^2) or the voltage cubed (E^3) rules, and also be able to estimate reductions in full value at different from normal voltage per turn. For small variations it is often astumed that pull varies as E^2 or as amp-turns^2. For high altitudes the coil voltage ratings must be reduced, the amount of reduction commonly used being a 10 per cent decrease in relative heat transfer capacity with each 5000 ft. elevation above sea level.

In this connection it is well to remember that various authorities on insulation aging at elevated temperatures agree approximately that every 10-15 deg. C. increase in operating temperatures above 105 deg. C. reduces the insulation life by 50 per cent. From this it should be evident that it is vitally necessary to compensate for high ambient, over-voltage, altitude or any other

Fig. 1. Cotton Interweave Coil

[1]Part I, page 82, July issue.
Part II, page 70, August issue.

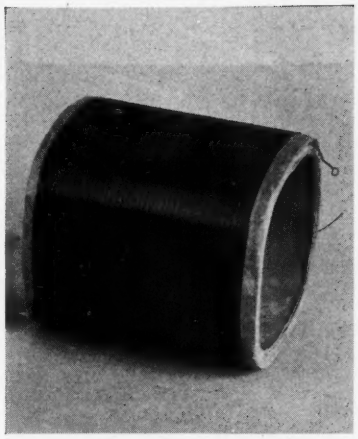


Fig. 2. Paper Layer Coil

condition which would tend to increase the normal temperature rise.

In alternating current applications to compensate for long line resistance, it is necessary to compute the effective resistance W/I^2, and from this find the maximum allowable series resistance which will permit sufficient inrush current to flow. Power factor determinations at open and closed magnet gap are also necessary and here it should be observed that the power factor may either increase or decrease, as the magnet closes dependent upon the relationship between the in-phase current as compared with the reactive component.

Practical selection of coils for various applications consists of knowing the service and life expectancy and providing the proper finish and materials to suit these demands. Often moisture protection is needed and here a heavily impregnated or asphalt coated or acetate constructed coil should be furnished. For other uses, possibly in the tropics, termite protection is desirable, for which special finishing varnishes are available.

For high temperature work, asbestos insulation, glass wire and glass tape finishes are used and the coil often fabricated from mica and brass parts or built on die cast aluminum spools.

In reference to inorganic wire insulation materials such as glass and asbestos glass has a decided advantage from a space factor point of view in practically all wire diameters. Asbestos on the other hand when used below 30 mil diameter requires such a large percentage of space for its insulation that its use becomes unsound except for high ambient conditions.

In other words in the finer wire sizes a Class "A" coil operating at 85 deg. C rise usually produces more amp-turns than a Class "B" coil at 105 deg. C rise if the Class "B" coil is made with asbestos insulated wire.

Factory Equipment

Due to the fact that no one coil design is suitable for all services or applications nor always the least expensive for the case in hand, there exists almost as great a variety of winding machines and other equipment as there are coils.

In practice, most every coil manufacturer in the country uses a different winding machine and quite often of his own manufacture. This and the fact that there is no absolute agreement between coil designers as to what type of design is most suitable for a particular application adds further to the assortment of equipment in common use. There is, however, general agreement on the necessity for multiple winding machines for large production items. If for paper layer winding these machines are all more or less up to date adaptations of the original "Varley" design with variations of its "paper flipper" mechanism, automatic stops at wire breakage, predetermining turn counters, paper "static eliminator," self-motivated knives for coil cut-offs and many other gadgets found desirable for specialty requirements.

Another class of winding machines is the so-called cotton interweave type which feeds cotton, silk or glass yarn in with the wire at a faster traverse rate than that at which the wire itself is running. Machines of this kind have until recently been used mainly to wind 1 or 2 coils at a time but are now available for "gang" operation.

In addition to the above broad types, there are numerous hand-winding machines essentially consisting of a motor with speed control, a counter and an adjustable "chuck" which will take most any size winding mandrel. Other equipment necessary for proper coil production include a multiplicity of small tools and fixtures and such items as solder pots, silver brazing pots, soldering irons, insulation cutters, conveyors, treating tanks and ovens, neon bulb open circuit test sets, electrical turn counters, induced voltage test sets, test set for shorted turns and inspection gages. In general, coil manufacture is getting ever more accurate following in the footsteps of better and closer designs. New insulation materials introduced in the last few years have also contributed a great deal to the neatness and finish of modern design.

A good deal more could be said about the detailed uses of these insulation materials and volumes may also be written about methods of starting and finishing coils, attaching leads or terminals and other general construction details, but space does not permit.

Defense Material Needs

BECAUSE of probable need of strategic materials for defense equipment over a 5-year period, Philip D. Reed, Chairman of the Board of General Electric Co. and consultant to the Director of Priorities of O.P.M. emphasized in an address before the Industrial Conference Board the planning to meet new conditions. He spoke of likelihood of shortages, of need to maintain maximum production for civilian needs without hampering defense output, and the desirability of keeping all America at work.

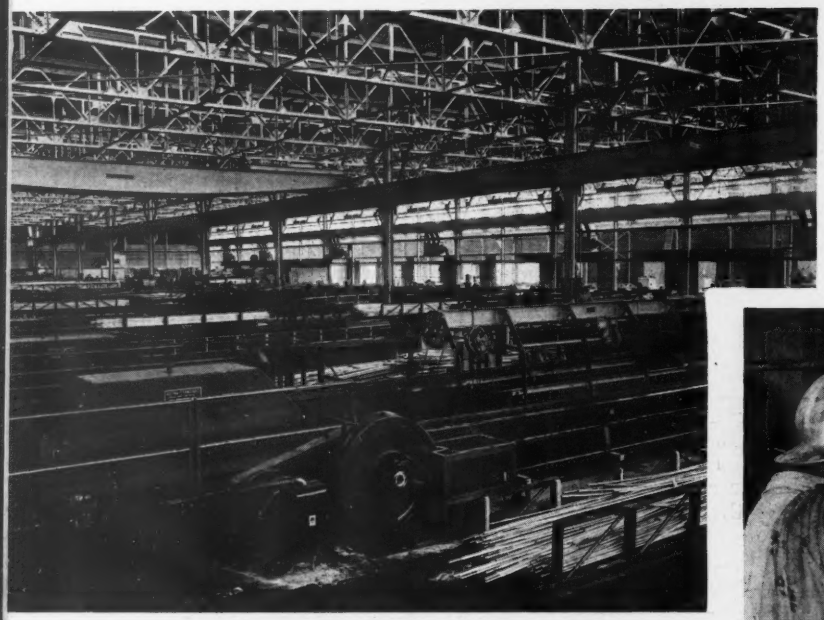
New products must be developed to absorb purchasing power and allay tendency to inflate prices. Substitutes must be developed for scarce materials. Scrap and used materials should be salvaged for reuse. Manufacturers will do well to study how they can take part in defense manufacture.

His feeling is that industry-wide planning and economic integration will expand, with Government supervision; that questions of hours, wages, and working conditions will be negotiated by a consolidated national labor organization and associations of employers led by able and understanding men; that there will be continued trend toward centralized control of money and credit.

Planned Government spending on desirable public projects will probably be necessary for several years after the war to cushion the sharp decline of work on armament, but such spending should be reduced as rapidly as possible and new industries given opportunity to take over the labor employed on public work.

PICTURES of Engineering

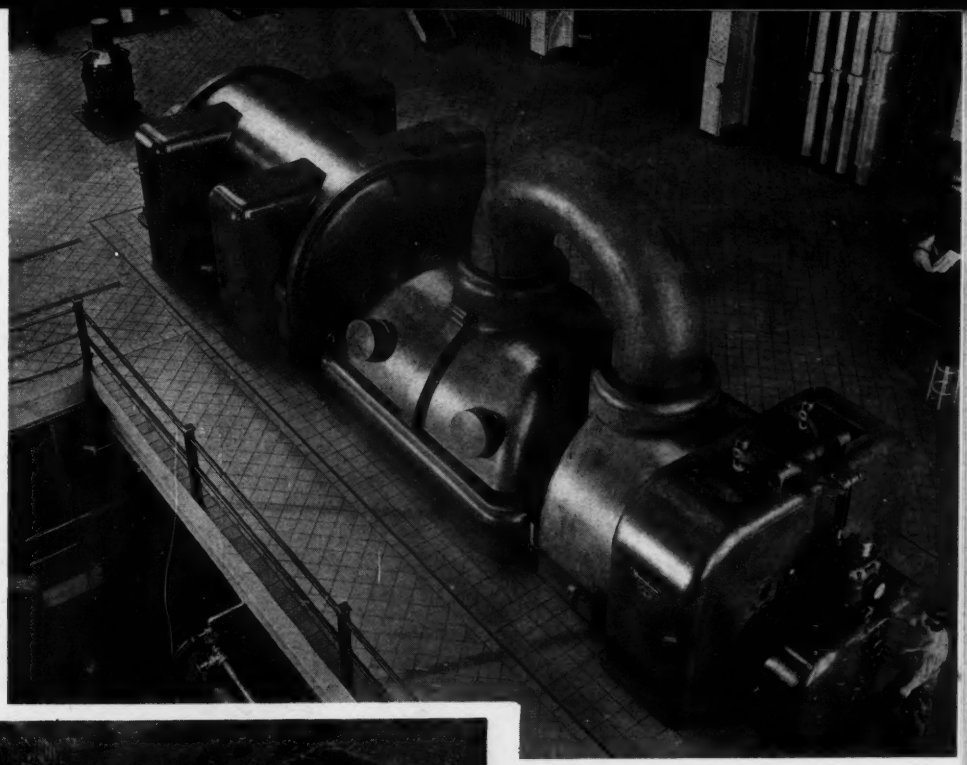
With approximately 17 per cent of the aluminum going into military planes today in the form of forgings, the Aluminum Company of America has almost trebled its forging capacity at its four forging plants. At Vernon, California, in the midst of the airplane industry on the West Coast, there has been a 350 per cent increase in manufacturing capacity. In the photograph at the right, a row of eleven of the twenty-one hammers in the factory are producing forgings for national defense even before the floor of the shop has been completed.



Another aspect of the aluminum industry is shown in the photograph at the left. This shows how aluminum tubing is being made for defense at the Lafayette, Ind., plant of the Aluminum Company of America. At this mammoth plant, expanded fivefold since hostilities began between Great Britain and Germany, tubing is being produced on a 20 shift a week basis for use in aircraft, naval vessels, signal equipment and other defense needs of the government. Production capacity by the end of this year will be nine times greater than at the start of the war.

Big Bolts. Bolts weighing 205 lb. apiece and shrunk a fraction of an inch by a half day's confinement in a box of dry ice are used in the assembly of the waterwheels and shafts of the Grand Coulee Dam turbine-generator units. Too heavy and too cold to be lifted by hand, the bolts are lowered into position with the aid of a small hoist. Before installation they repose for 12 and 16 hr. in 800 lb. of dry ice which reduces their diameter to a size that will permit their insertion into the flange openings. After being placed, the bolts return to normal temperature and expand; the result, a perfect fit. Eyebolts are screwed into the top of the main bolts during handling for to touch them with the bare hand would result in the loss of a layer of skin. The bolts are nearly 6 in. in diameter and they vary in length between 24 and 30 in. overall.

Interest



Early Fall Styles In Turbines. Sleek, smooth, streamlined, this new 3500-kw. Westinghouse turbine-generator at the Ohio Edison's Toronto Station exemplifies the modern trend toward better looking power station interiors. Its modern design with its smooth surfaces and rounded corners give the unit a pleasing appearance. Driven by a tandem condensing turbine operating at 800 lb. steam pressure, the generator is hydrogen cooled. It runs at 3600 r.p.m., delivers 42,750 kv-a. at 80 per cent power factor and a voltage of 11,500.

Charging over the crest of the concrete spillway, Lake Mead, in back of Boulder Dam, on August 6 overflowed for the first time. This is a year of ample water in the southwest, heavy run-offs, and full reservoirs. Lake Mead, the largest man-made lake in the world, is no exception. Before Boulder Dam was built, the flood waters uncontrolled this spring would have deluged the low lands below. The Bureau of Reclamation, which built Boulder Dam, welcomed the spill as an initial test of the great safety-troughs called spillways which flank the Arizona and Nevada sides of the great dam.

From turbine shafts to Howitzers. Defense production in full swing at the General Electric Co. The photograph at the right shows a row of 75 mm. pack howitzers being given their final hand finishing and assembly, just before the final tests and inspection in the Erie, Pa., works of the General Electric Co. These howitzers are produced on standard turret lathes and in midsummer were being produced at a rate of 35 per month in a department where electric railway motors are the usual product. The swing into defense production in this instance called for a minimum of special tools. The howitzer hurls a 15 lb. shell nearly 3 in. in diameter, 5 mi.

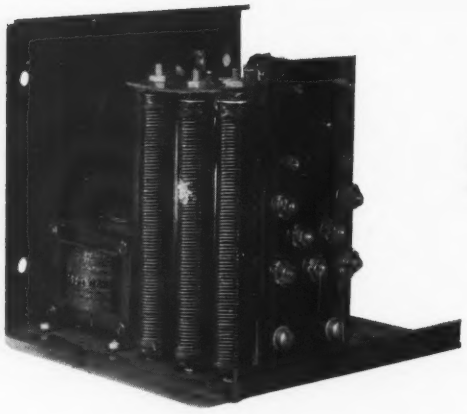


Fig. 1. A typical capacitor time delay unit. The transformer and three of the tubular resistors are visible. The time delay selector switch is on the upper section of the terminal board

Controlled Time Delay Prevents Faulty Tripping Of Circuit Breakers

BY G. D. GAMEL
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WITH the advent of centralized electrical power plants, with their large and complex distribution systems, there came the problem of preventing unnecessary circuit breaker operation due to excessive voltage dips, or temporary voltage failures. The great majority of undervoltage devices, being instantaneous in their operation, worked so rapidly that dips in voltage below 50 per cent of normal were sufficient to cause their tripping the circuit breaker. This condition was especially undesirable in systems where the main lines were equipped with automatic reclosers, because, by the time the main breaker reclosed, all the feeder breakers behind it would have been tripped by their undervoltage devices. Then, too, in some few instances severe voltage dips such as those caused by lightning, from switching operations, or the starting of a large motor were reflected over a considerable portion of the distribution system, causing unnecessary breaker tripping.

The property of the capacitor to store electrical energy has been put to work to correct this shortcoming. Use of a capacitor in parallel with an undervoltage attachment, to supply energy to the undervoltage device coil for short time intervals, has proven to be reliable and practicable. The characteristics of such a capacitor device in storing energy during normal periods of operation and discharging this stored energy to the undervoltage coil during abnormal periods, such as occur during voltage dips, or during automatic reclosing of a main circuit, is of undoubted benefit in preventing unnecessary and costly shutdowns.

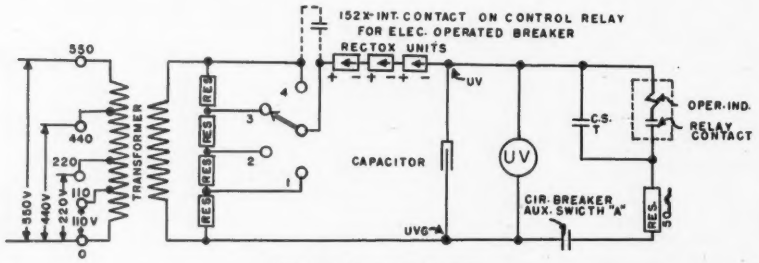

Fig. 2. Schematic Diagram

The time interval during which the undervoltage attachment should be held inoperative after voltage failure depends to a great extent on the characteristics of the supply source. Since the duration of voltage surges resulting from switching operations is ordinarily less than four cycles, and the outages on lines equipped with immediate reclosing equipment is ordinarily less than one second, the minimum time of stored energy supply to the undervoltage coil should not be less than 1 or 1½ sec. The maximum time of energy supply to the undervoltage coil is determined by

the ability of the apparatus to withstand the re-establishment of full voltage, which ordinarily is not over 4 sec.

A schematic diagram for one such capacitor device is shown in Fig. 1. The entire unit mounts in a 7 by 7 by 7 in. box and is suitable for mounting on any convenient vertical surface, such as the front of a switchboard. Its operation is very elementary and easy to follow through.

The primary of the transformer (Fig. 2) has five voltage taps, permitting use of one standard device on any of the more common control voltages. The transformer secondary impresses a fixed alternating current voltage across the potentiometer, and through the rectifier units also impresses a pulsating direct current voltage across the parallel capacitor and undervoltage coil circuits. The rectifiers, besides providing the pulsating direct current voltage, also act as a valve to prevent the capacitor from discharging back into the transformer circuit when the voltage on the primary side fails. The resistor-potentiometer dial on position No. 4 impresses full voltage on the capacitor; position No. 1 impresses

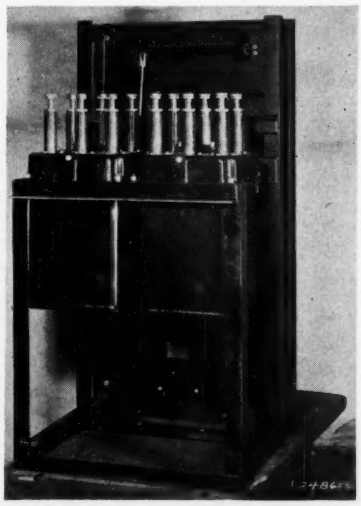

Fig. 3. This oil circuit breaker panel is equipped with time delay operation to prevent unnecessary tripping due to safe instantaneous voltage dips. The time delay unit is discernible in the center of the panel, under the two circuit breakers

approximately 50 per cent voltage. Thus the energy storage range is about 4 to 1.

Because the undervoltage mechanism is a rather sensitive device, it was found that the mechanical

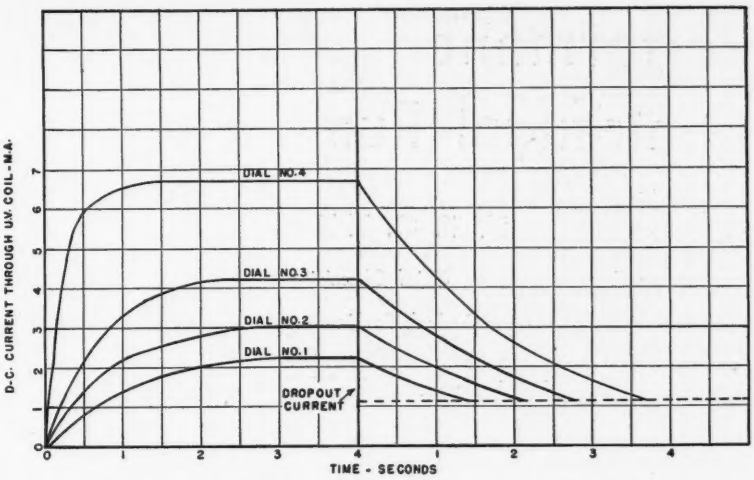

Fig. 4. Typical time-current characteristic for a capacitor undervoltage device. Characteristic curves are shown for each of the four selector positions

shock resulting from the breakers' closure would at times unseat the undervoltage armature and cause faulty trip operation when the undervoltage coil was operating on reduced voltage. To prevent such an occurrence the interlock 152X, shown connected across the No. 4 post and the arm of the potentiometer, is used. 152X closes when the breaker closing control relay is energized, impressing full voltage across the capacitor during the closing operation, thus preventing the UV armature from unseating, with consequent tripping of the breaker. When the control relay is automatically de-energized at the end of the closing stroke, 152X opens, and the voltage on the capacitor is immediately thereafter reduced to the desired potentiometer dial setting voltage. This arrangement is used only for electrically operated breakers.

The percentage of primary voltage at which the undervoltage attachment operates to trip the breaker varies with the dial setting. This follows since the direct current undervoltage coil must drop out on a fixed current and the charge in the capacitor is variable depending upon the resistor potentiometer setting. With the dial arm set on No. 1 post, the capacitor has only 25 per cent of its full charge with the result that the current through the undervoltage coil is approximately 25 per cent of its maximum value. Figure 3 shows the actual currents flowing through the undervoltage coil for the differential dial settings in relationship to the actual drop-out current. From this curve, it may be seen that the dropout voltage at No. 1 dial setting is 50 per cent of normal, whereas with the No. 4 dial setting it is 16 per cent of normal.

Although it is not ordinarily recommended that undervoltage attachments be used as shunt trips, emergency instantaneous tripping can be secured by connecting a control switch or a relay contact in parallel with the undervoltage coil to secure a low resistance discharge path for the capacitor and a low voltage condition across the coil when the contacts close. The 50 ohm resistor in series with the relay contacts reduces the arcing on them to a safe value. The breaker auxiliary switch in series with the relay contacts opens as the breaker opens, and permits the immediate recharging of the capacitor so that it will be ready for the next closure.

Capacitor equipments should, in all cases, be connected to the line side of the breakers to permit immediate recharging of the capacitor after the breaker opens. Approximately 0.2 seconds is required to charge the capacitor sufficiently to hold the undervoltage closed.

The widespread and trouble-free use of capacitors as energy reservoirs for undervoltage attachments demonstrates their effectiveness for this service. The field of utility of these devices covers practically the entire range of switchgear applications, the major activity occurring in motor starting and feeder circuit breakers.

Performance of Centrifugal Pump Packing

BY F. C. THORN*

Chief Chemist

Garlock Packing Co.

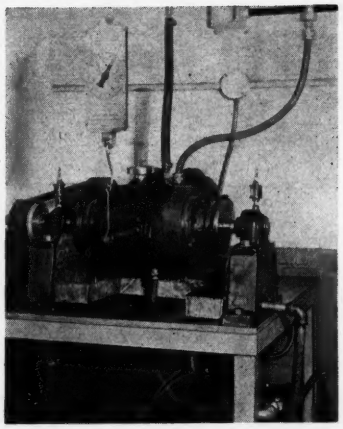

Fig. 2. Photo of testing equipment in laboratory

To the power plant operator nothing seems more temperamental than pump packing. Constant adjustment is necessary and even then satisfaction is questionable. The engineer has two ideals in mind—no leakage and no friction. It remained for the author of this two-part serial article to devise test methods and equipment for determining quantitatively what the balance should be between these two opposing ideals as applied to centrifugal pumps. He describes in this first part the equipment and method used and takes up the subject of leakage tolerance. In Part II he will give data on other variables that enter into the application of centrifugal pump packing

MANY ARTICLES have been written by various authors, including the writer (see "Packing the Centrifugal Pump," Journal of Industrial & Engineering Chemistry Vol. 31, p. 929) emphasizing the importance of operating variables, such as leakage, pressure, shaft gyration, etc., on the performance of centrifugal pump packings. To the best of my knowledge, no attempt has been made to give quantitative expression to these statements. The present article is designed to remedy, in part, this omission.

The apparatus used for the work is shown in Figs. 1 and 2. It consists of a shaft measuring 1¾ in. diameter over bronze wear-sleeves, which operate beneath the packings. The shaft is supported on pillow block ball-bearings, and is made to rotate, by means of a V-belt drive, at any desired speed. On it floats a steel barrel with inboard bearings of laminated phenolic resin. Rotation of the barrel is prevented by an outrigger arm attached to a spring balance, which serves to measure the developed frictional torque. The two packings are contained in stuffing boxes of conventional design at opposite ends of the barrel. Each box holds five packing rings measuring 1¾ by 2¾ by ½ in. each (approximate), and is tightened manually by a gland and four gland bolts.

*This article is based to a large extent on a paper read by the author, before Sub-Committee VI on Packings, A.S.T.M. Committee D-11 at Washington, D. C., March 5, 1941. It is published with permission of the A.S.T.M.

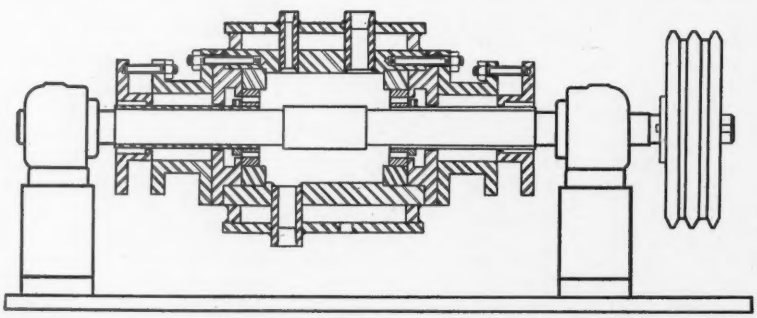

Fig. 1. Cross section of apparatus for testing centrifugal pump packing

Test Methods

When used for testing packings for water service, the apparatus is filled with water at the desired pressure by means of a hose connection at the bottom, the hose being arranged with sufficient slack so as not to interfere with the torque reading. At the time of filling, air is released through a valve at the top of the barrel. Temperature of the water in the barrel is controlled by water admitted to the jacket through a second hose and discharged continuously through an open vent at the top. Temperature is assumed to be that of the jacket water which, for tests at 150 deg. F. is controlled in turn by a coil-heater and thermostat, not shown. (When controlling at 212 deg. F., atmospheric steam is admitted at the upper vent, and discharged through the bottom connection.)

Leakage is collected and measured. For the "shaft gyration" tests, to be described later, bronze wear-sleeves of a known degree of eccentricity are substituted for the concentric wear-sleeves beneath the packing. The clearances at front and rear of stuffing boxes are wide enough to permit these to rotate without disturbing the barrel, the resultant vibration being wholly absorbed by the packing. It will be seen that this apparatus embodies all the service conditions which packings are forced to encounter on centrifugal pumps handling pure water at positive pressures, or any material at any pressure as long as pure water at positive pressure is introduced into the center of the packing via a lantern ring.

The packings used in these tests (Fig. 3) consisted wholly of rings cut from braided asbestos coil, with butt joints. This is a standard water-pump packing and consists of asbestos yarns individually saturated with a blend of petrolatum and an animal fat,

coated individually with flake graphite, made into multiple-strand twists which are then braided on a conventional eight-carrier braiding machine, with four corner strands of the same type to preserve the square cross section. This construction is generally known in the trade as "graphited throughout." The uncompressed volume of a five-ring set of this packing is very close to 9 cu. in., it is capable, however of being compressed to about 5.4 cu. in. with loss of most of the contained saturant, and part of the graphite. Compression beyond this point is very difficult, and does not bring additional supplies of saturant to the surface. Practically, a packing has reached the end of its useful life when this condition is reached.

Gland Adjustments

In all the tests to be described, the packing sets were installed with the gland nuts finger tight; water introduced; gland nuts further tightened as necessary to hold water leakage to the prescribed maximum; rotation commenced; and further gland nut adjustments made as necessary to keep the leakage from exceeding the prescribed rate. As the manner of making these adjustments has an important effect on the resultant performance, it will be described in some detail. Whenever measurements of escaping water over a period of several minutes indicated that the prescribed rate was being exceeded, the gland nuts on that particular stuffing box were all advanced 0.005 to 0.010 in. and not disturbed again for 15 min., when a further advance was made, if the need for it was indicated. The reason for the 15 min. interval is that the minimum leakage is not attained immediately after tightening, but from 5 to 10 min. thereafter, due, no doubt to local heating and consequent thermal expansion. The effect of retightening should not, therefore, be judged too early as it might lead to overtightening. Throughout these adjustments, a continuous record is kept of packing volume.

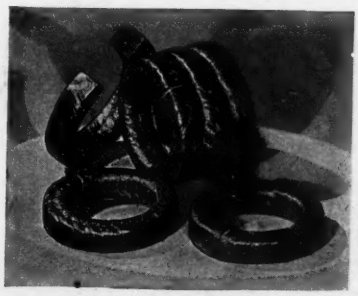

Fig. 3. Style of packings tested

The immediate effect of gland adjustment seems to be that extrusion of some saturant from the interior of the packing into the braid interstices facing the shaft, fills these up and presents a fairly level surface to the shaft. Increased leakage results from the more or less gradual erosion of this extruded saturant. The erosion of the saturant and consequent frequency of readjustment does not, however, proceed at a uniform rate throughout any single test. There is always a rapid initial loss of saturant with relatively frequent adjustments; after this has proceeded to a certain degree, depending upon the severity of conditions to which the packing is exposed, a point is reached at which further loss of saturant and consequent need for further adjustment are greatly minimized.

In general, centrifugal pump packings cannot be said to work properly until this "stable" period of operation is attained. The stable period does not endure forever, and is succeeded by a later unstable period with frequent adjustments, culminating in the condition of complete compression previously described, when no further reduction in leakage can be effected by gland adjustment. In the tests about to be described, the stable period was still continuing when the test ended at 1000 hr., so it cannot be said that we have arrived at an accurate measure of packing life. It is fairly obvious, however, that the closer the packing volume is to the original volume at 1000 hr., and the farther it is from the state of maximum compression, the longer the subsequent packing life which may be anticipated. There is justification, therefore, for using the volume loss prior to stabilization as an inverse measure of the packing life to be expected.

Leakage Tolerance

In the chart (Fig. 4) we show the effect of varying the leakage tolerance. The conditions common to this series of tests were (a) speed 1800 r.p.m. approximately, (b) water at 25 lb. pressure, (c) jacket at 70 deg. F., (d) wear-sleeves concentric, or nearly so, (e) five-ring packing set. We have shown changes in packing volume with time when the maximum tolerated leakage was (1) 10 c.c. per min., (2) 2 c.c. per min., (3) none. We have, however, described the last provisionally as "½ c.c. per min.," because we have reason to consider that about this amount of water was escaping, but was invisible due to flashing to steam as soon as it reached the outside. Of course, it is recognized that leakage did not proceed throughout each test at the figure indicated as maximum. In the interval between adjustments it was generally lower. The maximum tolerance serves, however, as an index of the average leakage throughout each test. In each test there are two curves, the solid curve representing the performance of the box nearest the pulley, and the dotted curve representing the performance of the box farthest from the pulley. Not all the adjustments can be shown, especially during the early hours. In general the two curves check each other, but not so well in the case of the leakless test, which is not difficult to understand in view of the difficulty of deciding just when is the right time to tighten. It will be noted that each test, starting from an initial volume of close to 9 cu. in. declined rapidly to a stable condition, the number of adjustments within this period being too many to record on the curve. It will be noted also that very few adjustments were made thereafter, except in the leakless test in which a period of renewed instability set in after 640 hr. The volume loss at 1000 hr. is seen to be inversely related to the permissible leakage; hence, by indirection, we may say that packing life varies directly as the permitted leakage. This latter is a qualified statement, until we have actual tests conducted to the point of packing failure.

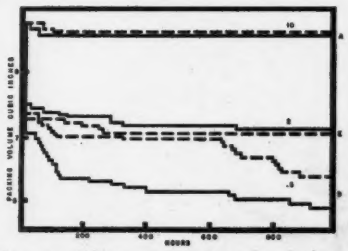

Fig. 4. Effect of varying the leakage tolerance

(To be continued.)

Heat Recovery From Continuous Blow-Down

By means of the continuous blow-down system with heat exchangers, losses due to heat carried to waste are reduced to a minimum and boiler water impurities are kept under control. The method of calculating heat recovery is explained here by a specific completely calculated example

By W. F. Fisher*

ALL NATURAL waters contain either in suspension or in solution a certain amount of organic or inorganic foreign matter. Impurities held in mechanical suspension—such as oil, grease, sediment and earthy matter, can be removed from the water by some ordinary form of filtration, but filtration has no effect on the substances that are dissolved in the water.

The scale-forming substances, such as carbonates and sulphates of magnesia and lime, the soluble salts of silica, iron, and alumina, may be rendered harmless by some form of chemical treatment applied before the water enters the boiler. Most of the scale-forming substances become insoluble and are precipitated when the water containing them in solution is heated to a sufficiently high temperature.

Precipitated matter may be removed from the boiler by the simple process of "blowing-off" but if this is not done at frequent intervals the boiler water may become so highly concentrated that the precipitated matter may cause the generation of wet steam or even the more violent priming. The precipitated matter carried over with the moisture in the steam may be deposited in the superheater tubes, if a superheater is used; or may be carried over to the steam main and even to the engine cylinders and turbines where it deposits on the blades—thus causing more or less damage to the plant machinery. Precipitated matter remaining in the boiler will, in time, collect and bake to a hard crust or scale on the tubes and other heating surfaces.

Impurities in boiler feedwaters are usually measured as parts per million, which is abbreviated p.p.m. Grains per U. S. gallon may be converted into parts per million by multiplying by 17.14. The permissible p.p.m. of total solid residue in the boiler water may be controlled by continuous blow-down of the boiler while in operation. This method of deconcentration may, however, result in a considerable loss of heat, unless some means is provided whereby the heat contained in the water can be utilized to good advantage before wasting the water to the sewer.

Deconcentration by Continuous Blow-Down

A system of deconcentration by continuous blow-down in which provision is made to utilize the heat contained in the blow-off water to heat the feed and make-up water is illustrated in Fig. 1. The system is entirely automatic in operation and can be used for one or more boilers. The feedwater to each boiler is controlled by a feedwater regulator (1) and the amount of blow-off from each boiler by a regulated "blow-down apportioner" (2). An adjustable orifice (3), a fixed orifice (4), and an ordinary shut-off valve (5), are provided in the blow-off connection from each boiler as shown in the illustration. The blow-off water enters the high-temperature heat exchanger (6), where it gives up a large part of its heat to the feedwater from the open or atmospheric heater (12) before it is delivered to the boilers. Leaving the high-temperature heater, the blow-off water is then passed through the low-temperature heater (7) where the remaining heat is utilized to heat the cold make-up water before it is sent to the open heater (12). After leaving the low-temperature heater (7), the blow-off water is passed through a pressure regulating valve (8) before going to the recording meter (9) and main proportioning valve (10), and thence to the sewer or waste. The diaphragm of the main proportioning valve is operated by a device installed in the make-up line as shown. The amount of raw make-up water passing through the low-temperature heater, and thence to the open heater, is regulated by the

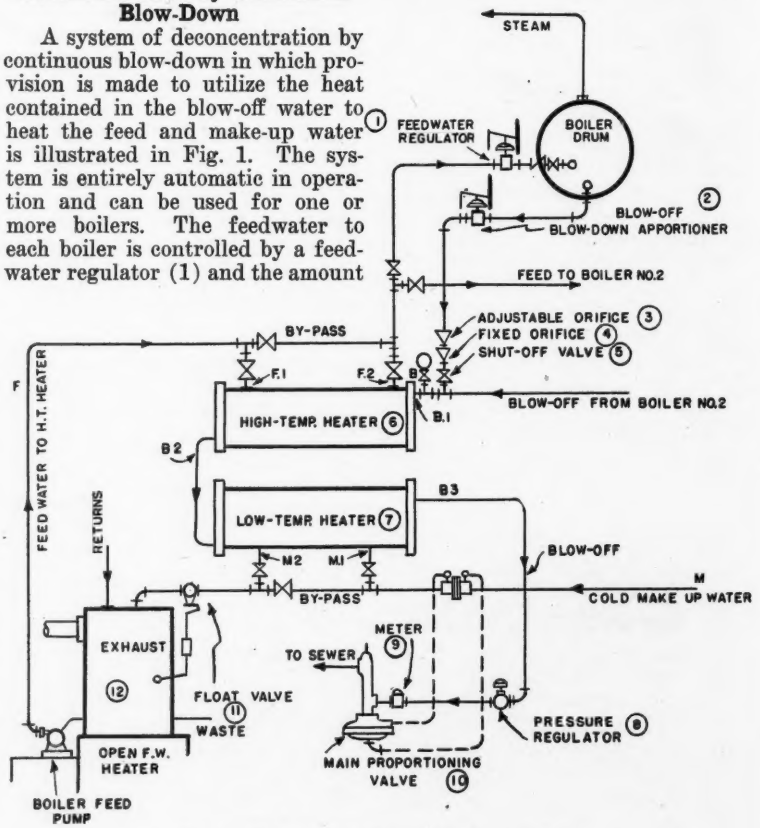

Fig. 1. Diagram of continuous blow-down system

*Deceased.

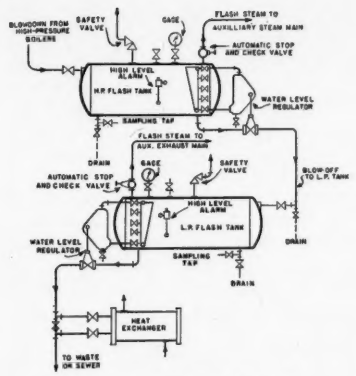

Fig. 2. Hookup for flash tanks

float-operated valve (11) on the open heater—in the usual manner. The closing of this valve causes the pressure to build up in the make-up line, which in turn operates the diaphragm of proportioning valve (10) and thus regulates the amount of blow-off water that is wasted.

Amount of Heat Recovered

Suppose, for example, there are two boilers, and that each boiler is required to evaporate, say, 35,000 lb. of water per hr. into steam at 400 lb. per sq. in. abs. pressure: that the amount of make-up water ordinarily required is 10 per cent of the amount evaporated, or 7000 lb. per hr. at a temperature of 60 deg. F. and that a continuous blow-down of 2½ per cent of the quantity evaporated or 1750 lb. per hr. is required in order not to exceed the permissible concentration of solids in the boilers.

In this case, then, we must feed (70,000 + 1750) or 71,750 lb. of water per hr. to the two boilers, and the total amount of make-up water will be increased from 7000 to 8750 lb. per hr. It is further assumed that the feedwater leaves the open heater at a temperature of 212 deg. F. and that all heat loss from the system by radiation is to be ignored in the computation.

Referring to Fig. 1, let

- b_1 be the unit heat content of the blow-off water in B.t.u. per lb. above 32 deg. F., entering the high-temperature heater (6).
- b_2 that of the blow-off water leaving the high-temperature heater and entering the low-temperature heater (7), and
- b_3 that of the blow-off water leaving the low-temperature heater.

Likewise, let

- f_1 be the unit heat content of the feedwater entering, and
- f_2 the unit heat content of the feedwater leaving the high-temperature heater
- m_1 the unit heat content of the make-up water entering, and
- m_2 the unit heat content of the make-up water leaving the low-temperature heater.

Then if F is the amount of feedwater leaving the open heater and going to the boilers; B the amount of blow-off water; and M the amount of make-up water, all in lb. per hr., we have the following equations:

For the high-temperature heater:

$$B\ (b_1 - b_2) = F\ (f_2 - f_1)$$

For the low-temperature heater:

$$B\ (b_2 - b_3) = M\ (m_2 - m_1)$$

From these two equations we get,

$$f_2 = \frac{B}{F} \times (b_1 - b_2) + f_1 \qquad (1)$$

$$m_2 = \frac{B}{M} \times (b_2 - b_3) + m_1 \qquad (2)$$

The temperature of the water in the boiler for corresponding steam pressure of 400 lb. abs. is found from the steam tables to be 444.6 deg. F. and the heat of the liquid 424 B.t.u. per lb. above 32 deg. F.

Hence $b_1 = 424$; $f_1 = (212 - 32) = 180$; and assuming 10 degrees temperature difference between the blow-off entering and the feedwater leaving the high-temperature heater, $b_2 = 180 + 10$, or 190 B.t.u. per lb.

By equation (1)

$$f_2 = \frac{1750(424 - 190)}{71{,}750} + 180 =$$

185.71 B.t.u. per lb., and the temperature of the feedwater going to the boilers will be approximately 218 deg. F.

The blow-off water, therefore, gives up 1750 × (424—190) or 409,500 B.t.u. per hr. to the feedwater in the high-temperature heater, and since the blow-off water contains 424 B.t.u. per lb. the total amount of heat removed from the boiler in the blow-off water will be 1750 × 424 or 742,000 B.t.u. per hr. above 32 deg. F. We see, therefore, that

$$100 \times \frac{409{,}500}{742{,}000} \text{ or } 55.2 \text{ per cent}$$

of the heat will be recovered in the high-temperature heater.

The make-up water enters the low temperature heater at a temperature of 60 deg. F. Therefore $M_1 = 60 - 32$, or 28 B.t.u. per lb. Assuming the same temperature difference as before, that is 10 deg., then $b_3 = (60 + 10) - 32$, or 38 B.t.u. per lb.

By equation (2),

$$m_2 = \frac{1750(190 - 38)}{8750} + 28, \text{ or}$$

58.4 B.t.u. per lb. and the make-up water leaves the heater at a temperature of 90.4 deg. F.

The blow-off water, therefore, gives up 1750 × (190—38), or 266,000 B.t.u. per hr. to the make-up water in the low-temperature heater, or

$$100 \times \frac{266{,}000}{742{,}000} \text{ or } 35.85 \text{ per}$$

cent of the total amount of heat it contained when leaving the boilers. The total amount of heat recovered from the blow-off water is, therefore, 409,500 + 266,000 or 675,500 B.t.u. per hr., which represents 91 per cent of the total amount of heat leaving the boiler.

At two cents per 100,000 B.t.u. this would represent a saving of $0.135 per hr.; $3.24 per day of 24 hr.; or $1,182.00 per yr. continuous operation.

The heat exchangers would, of course, have to be constructed with sufficient heat transmitting surface to obtain these results.

Flash-Steam from Continuous Blow-Down

Provided the boiler pressure is high enough to warrant doing so, and that continuous use can be made of the flash-steam thus generated, an arrangement of flash tanks similar to that shown diagrammatically in Fig. 2 can be used to good advantage.

The water blown down from the high-pressure boilers is delivered directly to the high-pressure flash tank where a part of it is flashed to steam at a lower pressure. The water remaining unevaporated in the high-pressure tank is then delivered to the low-pressure tank where a part of it is flashed to steam at a still lower pressure. The remaining water, containing the solid material blown off from the boilers, is then passed through a heat exchanger—to heat

the make-up water before being discharged to the sewer.

The flash tank should be large enough to provide ample volume for the separation of steam from the water, and should be baffled in such a manner that water or moisture will not be carried over by the steam leaving the nozzle. Each tank should be equipped with an automatic stop and check valve at the steam outlet; a pop-safety or automatic relief valve; steam gage; water level indicator and regulator; high-water level alarm; thermometer; try-cocks; drain connection; sampling taps; etc., as required.

Let us assume, that the high-pressure boilers operate at a pressure of 800 lb. per sq. in. abs.; that the continuous blow-down of, say, 10,000 lb. of water per hr. is required in order not to exceed the permissible concentration of solids in the boilers; that the flash-steam from the high pressure tank is to be discharged directly to the auxiliary steam main, at a pressure of 125 lb. per sq. in. abs.; and that the steam from the low-pressure flash tank is to be discharged to the auxiliary exhaust main, at a pressure of 17 lb. abs.

From the steam tables we find that each pound of blow-off water contains 510 B.t.u. above 32 deg. F., so that there will be delivered to the high-pressure tank

$510 \times 10{,}000$, or 5,100,000 B.t.u. per hr.

At 125 lb. per sq. in. abs., the heat of the liquid is equal to 315.68 B.t.u. and the latent heat of evaporation, 875.4 B.t.u. per lb. Each pound of water entering the high-pressure tank, therefore, gives up 510—315.68 or 194.32 B.t.u. and this amount of heat will flash

$194.32 \div 875.4$ or 0.222 lb. of the water to steam at 125 lb. abs. pressure.

The total amount of steam generated in the high-pressure flash tank is, therefore $0.222 \times 10{,}000$, or 2220 lb. per hr., leaving 7780 lb. of water per hr. to the low-pressure tank, each pound containing 315.68 B.t.u. per lb.

At 17 lb. abs. pressure, the heat of the liquid is equal to 187.5 B.t.u. per lb. and the latent heat of evaporation 965.5 B.t.u. per lb. The amount of heat released per pound of blow-off water in the low-pressure flash tank is, therefore

315.68 — 187.5 or 128.18 B.t.u. per lb. and this amount of heat will flash

$128.18 \div 965.5$ or 0.1327 lb. of the water to steam at 17 lb. abs. pressure.

The total amount of steam generated in the low-pressure flash tank is, therefore,

0.1327×7780, or 1032.40 lb. per hr., leaving 7780 — 1032.40 or 6747.6 lb. of water per hr. going to the heat exchanger, each pound of this water containing 187.5 B.t.u. above 32 deg. F.

Taking the temperature of the make-up water entering the heat exchanger as 60 deg. F., and assuming the heat exchanger to be designed to work on a 10 deg. temperature difference, the heat content of the blow-off water wasted to the sewer would be 38 B.t.u. per lb., so that each pound would give up

187.5 — 38 or 149.5 to the make-up water.

The total amount of heat extracted from the blow-off water in the heat exchanger would then be equal to

149.5×6747.6 or 1,008,766 B.t.u. per hr., while the amount wasted to the sewer would be

38×6747.6 or 256,408.8 B.t.u. per hr.

The percentage of heat recovered in the high-pressure flash tank amounts to $100 \times (194.38 \div 510)$ or 38.1 per cent; that recovered in the low-pressure flash tank,

$100 \times (128.1 \div 510)$ or 25.1 per cent; that recovered in the heat exchanger,

$100 \times (149.5 \div 510)$ or 29.3 per cent; and the percentage of heat wasted to the sewer,

$100 \times (38 \div 510)$ or 7.46 per cent.

At 20 cents per million B.t.u., the cost of 5,100,000 B.t.u. per hr. amounts to $1.02 per hr. We see, therefore, that the saving made possible by the high-pressure flash tank amounts to 38.1 per cent or $0.3886 per hr.; that due to the low-pressure tank, 25.1 per cent or $0.256; that due to the heat exchanger, 29.3 per cent or $0.299 per hr.; and the waste to sewer, 7.46 per cent or $0.0761 per hr.

Amount of Solid Matter Carried Over in Wet Steam

Failure to provide sufficient separating space and proper baffling in the flash tank would, undoubtedly, result in a high percentage of moisture being carried over in the steam mains. Perfectly dry saturated steam will, of course, be entirely free of solid matter, but the moisture contained in wet steam will carry over a certain amount of solid matter with it.

Let us say, for example, that the water blown down from the boilers contains 5000 p.p.m. of soluble salts in solution, and that the 10,000 lb. of water blown down every hour carries with it

$(5000 \div 1{,}000{,}000) \times 10{,}000$,

or 50 lb. of solid matter per hour, to be deposited in the high-pressure flash tank.

Assuming the flash steam leaving the high-pressure tank to carry with it, say, 4½ per cent of water or moisture in suspension, the 2220 lb. of flash steam leaving the tank per hr. will carry with it,

0.045×2220, or approximately 100 lb. of moisture; and this amount of moisture will, in turn, carry over with it

$(5000 \div 1{,}000{,}000) \times 100$ or 0.5 lb. of solid matter per hr. or 12 lb. per day, to be deposited in the steam main.

Since the amount of blow-down water going to the low-pressure flash tank is equal to 7780 lb. per hr., the concentration of solids or parts per million in the water will be increased to

$$\left(\frac{50-0.5}{7780}\right) \times 1{,}000{,}000, \text{ or to } 6362$$

p.p.m.

If, as before, the steam leaving the low-pressure tank is 4½ per cent moist, the 1032.40 lb. of steam leaving the tank every hour will carry with it

0.045×1032.40 or 46.46 lb. of moisture, and this, in turn, will carry with it in the steam,

$$\frac{6360 \times 46.46}{1{,}000{,}000} \text{ or } 0.2955 \text{ lb. of}$$

solid matter per hr., or 7.09 lb. per day.

Solid matter carried over with the steam in this manner may cause more or less damage to reciprocating engines or steam turbines, and to guard against this the steam should be passed through an efficient steam separator before entering the turbine or engine cylinders, so as to insure dry steam or steam with as little moisture as possible.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

ONE PICTURE EQUALS, ETC., ETC.

YOU ALL know various versions of the old Chinese proverb which insists that one picture is equal to 10,000 words. We have never figured it out on our slide rules and if it applies to pictures[1] of the type drawn by that great versatile genius Pulverizer Pete, we won't ever try—we'll take the 10,000 words. However, people seem to like the pictures we show on our Shop Talk page and a number have written in asking us to show more of them. This is swell, just what we like as it saves us writing a lot of words. Five pictures on a Shop Talk page—ergo, 50,000 words, just like that. But where to get the pictures, that is another matter. We get some but we would like to have a lot more. Hence this appeal for help. Surely you have rigged up some gadget or trick arrangement around your plant that will be of interest to others and of which you can be proud. Well, why not get out your old Brownie, and take a picture of it, or if you have a photographic nut around your plant (and every plant has one) get him to do it, then send the result to us and the chances are 10 to 1 we will publish it. And think of the joy of seeing your name in print. Your friends will look up to you.

A. W. K.

[1]See page 86

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

Boy, Oh Boy, here is an article that beats any Agatha Christy novel for sheer and unadulterated imagination. We recommend it for light post-vacation reading. If you survive you can consider yourself strong and healthy, but if you pass out, don't let your relatives blame us. We present it without comment, without support, and any names of persons and places or ideas appearing in the article are purely incidental. The drawing, if it can be called one, is also that of the author —we had nothing to do with it. Read it at your own risk.

SAFE FIRING of Modern Steam Generators

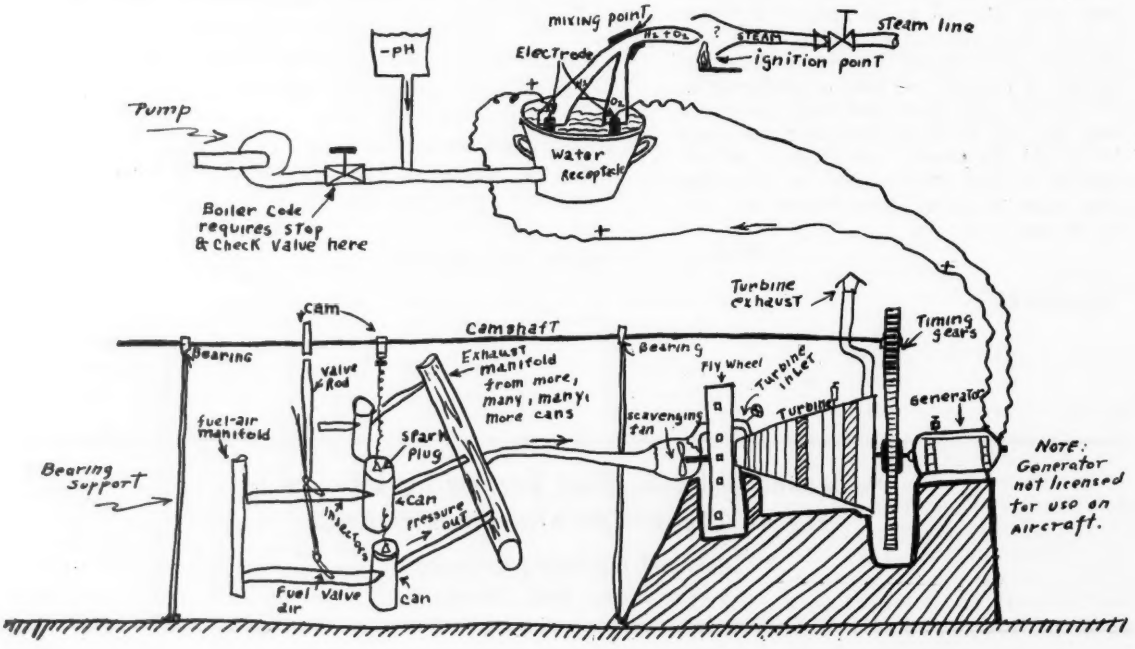
By PULVERIZER PETE

ONCE UPON A TIME there was a guy . . . in fact once upon a time there was two guys. And I does mean was.

One of these guys had a gas-fired boiler and one day he decides to shut down the boiler. The best way for to do this is to shut off the gas; or you could let all the water out, then no steam would come out either which is what you wants. Anyway, this guy shuts off the gas. Now what he don't know he has got is a leaky gas valve. What he ain't got is a vent to the atmosphere on the furnace side of the gas valve, which (the vent) is open when the gas valve is shut. So the valve goes on leaking and the gas goes on not being vented so pretty soon he has got something else. And that is a furnace full of a nice explosive mixture.

Then after a while he is ready to start up again. Does he give the fan a chance to scavenge the furnace, no, he is in a hurry. In goes the lighting torch. The result ain't indescribable—it is describable in one word and that's: BOOM! Now the guy is taking a correspondence course in harp-plucking and halo juggling—or maybe pitchforking.

The other guy was running a pulverized-coal fired plant. It was (I still mean was) a swell little layout. It was all full of interlocks and meters and automatic controls and what not, so this guy has nothing much to do except try to figure out if this Bacon fellow really writes Shakespeare and if he did what he says to him. So one day he is sitting and thinking and the plant is running itself under low load. Then all of a sudden he loses ignition (why, ain't the point—it's just got to be in



the story). The mill keeps on milling. The pulverizer fan keeps on puffing. The pulverizer coal-air mixture in the furnace keeps getting enriched. How come? Well, the one gadget this plant ain't got is a flame failure detector.

Eventually, this guy sees his fire is out. He also sees where all his stuff is still running so he figures all he's gotta do is push the button in the automatic lighter circuit. Which he does. Now what all the experts like me what reads this knows will happen, does. I elucidates: the four furnace walls goes in six different directions, the pressure parts get bent like a pretzel, if the operator makes a good landing he gets the Bendix Trophy.

So what does we conclude from this. I tells you. As long as we got plants without vents, interlocks, and with operators what is not perfect in the head like me we is apt to have explosions. Now, does I run out and get more insurance, no, I invents a explosion proof furnace.

Now don't nobody jump at no conclusions. I doesn't just make the furnace stronger on account that ain't practical. Did any of youse fellers ever figure out what pressure you gets in a furnace should a explosive mixture of natural gas blow up in it. Well it's about 8000.064 mm. of mercury if I ain't wrong and that's something, the pressure I mean.

Yes, I not only invents a new furnace, in fact, when I sees what gets called furnaces and boilers today I guesses it is up to me to develop a new kind a steam generator for me to safely fire.

First of all I gotta jolt youse a bit. In my new generator I does not prevent explosions, I deliberately causes them. But I causes them in small tin cans with thick heads and walls like automobile engine cylinders where they can't get out and cause trouble. On account of they is small I gotta use quite a lot to explode enough fuel to generate say 500,000 lb. of steam in a hour. So anyhow I fills the cans with a fuel-air mixture and explodes it.

Now what has I got (if the cans hold)—I has got what is ordinarily flue gas or furnace exit gas at a high pressure. There is three things I can do with it. I can have it push a piston like in a Ford, I can forget all about it, or I can have it spin a turbine. No matter what ideas youse got, in my generator it spins a turbine. Thus we got in principle the first part of the cycle. But in a big plant you can't be running around opening the cans, dumping in fuel and air, closing them up, exploding the fuel, and doing it over again because in the first place the turbine wouldn't run smooth and anyway the operators would get tired. So the cycle has got to be continuous which I does by hooking some gears on the turbine up with some valves in the fuel lines and spark plugs in the cans. The picture shows this pretty good and if you ever hears about cam shafts and timing gears in a automobile you gets the point. The point is, the fuel valves is shut while the pressure is running out of the cans into the turbine. Speaking of timing gears, in my latest spring models with chrome plated nuts, the timing gears is arranged to make all the cans not explode at the same time. This is for to make the turbine run smoother. The super delucks model has also got a flywheel on the turbine to keep it going awhile should maybe something else get out a wack.

By this time some wise guys who admits they is Diesel experts will squawk about scavening the cans before the valves opens for a fresh dose a fuel. Well, the best scavengers I knows is sea gulls but they ain't practicable in inland plants so I solves this problem another way with my usual genius. I just puts a exhaust fan on the front of the turbine rotor and when the pressure stops pushing the fan sucks the rest of the flue gas out a the can because the turbine is still spinning on account of inertia.

At this point we got a turbine spinning—what does we do with it. We can drive a boat or maybe a ice cream freezer or maybe not. In my brain? child it drives a direct-current generator. Why? For to get electricity—So this ain't steam like my invention is supposed to put out, but don't nobody be disappointed, my generator ain't done yet. I takes this plus and minus electricity and hooks it up to a couple electrodes. These electrodes I puts in the water storage receptacle (see picture) of the Pulverizer Pete steam generator which is supplied by a conventional boiler feed pump with a slightly minus pH water.

Now maybe you gets a vague notion of what happens. If any of youse has read your encyclopedia in the part marked water (or maybe its under electrolysis) you recalls that the electric pluses chase the minuses through the water so fast it gets knocked all to bits. In fact it gets batted right back into the hydrogen and oxygen it was once. Which still ain't steam but the next finishes the process. The two gases is mixed and a match (lit) is applied to the mixture. (One match takes care of one generator.) Result: $2H_2 + O_2 = 2H_2O$ which H_2O is in this case steam and whats more it is steam what ain't got no p.p.m's of carry-over in it, which is more what some boiler manufacturers can say. Of course maybe it is a little hard to control the quickness of this steam generation and collect the steam, but also maybe it is a little hard to collect the generator at this stage of the process.

I figures out the efficiency of this here generator and it comes out 99 per cent. Now it could be there is some zeros in front of that number what I forgets about seeing I don't never use decimal points it don't matter.

NOTE: This article is essentially a preprint of a paper to be presented before the Dec. 31 meeting of the SPCPP (Society for the Prevention of Cruelty to Pulverizer Pete).

REFRIGERATING PRACTICE

Notes on Tables of Properties of Refrigeration

By A. G. Solomon*

WITH THE INCREASING use of small refrigerating systems using Freon, Sulphur Dioxide, etc., there is a tendency to leave specific knowledge of these newer refrigerants to the manufacturers making the equipments. The operator is rarely given an opportunity of learning much about the properties of the refrigerants used and their strange names often mystify him.

The tables of the properties of the new refrigerants are, however, easily available and since they are essentially no different from tables giving the properties of ammonia, they can be understood by anybody making an effort to do so. The complex name Dichlorodifluoromethane which is the chemical name for Freon makes no difference in the structure of the tables of properties of refrigerants.

If we examine a table giving the properties of Freon, for example, it will be noted that it contains about the same sets of values as the older and more familiar ammonia table. The table is divided into two parts, the first giving the properties of Freon in its saturated vapor state, the second, the properties of the superheated vapor.

As a starting point it is well to consider what the word "saturated" means when applied to vapor circulated in a refrigerating system. When the vapor of any refrigerant is in a saturated state, the pressure and temperature are directly related to each other, for each value of pressure there is a corresponding value of temperature. Hence when one is known the other also can be found.

Pressure-temperature Relation

A knowledge of this pressure-temperature relation is necessary in colving most refrigerating problems. Both absolute and gage pressures are given in the 2nd and 3rd columns. The gages on many refrigerating systems show the pressure and corresponding saturated temperatures. Such markings should not mislead one in assuming

*Deceased.

that the temperature shown on the pressure gage is the correct temperature of the refrigerant in the suction line close to the compressor where the low pressure gage is connected. The vapor at this point in the system is usually superheated and therefore the pressure-temperature relation does not hold.

In the evaporator, the refrigerant is taking up heat and is saturated. Also it is mixed with entrained liquid. By absorption of heat this liquid becomes dry, saturated vapor. When leaving the evaporator the refrigerant should be either a dry saturated or a superheated vapor. Entrained liquid should not be carried over or leave the evaporator and enter the main suction line.

The next two columns in the table usually give the volume of liquid and saturated vapor in cubic feet per pound. The column of volume of the liquid is very seldom used by the average engineer so we will not consider it here.

The volume of the saturated vapor enters into many problems although it rarely happens that any compressor becomes filled with saturated vapor entering through the compressor suction valves. The heat of the cylinder walls, cylinder heads, pistons and valves usually causes complete evaporation and superheating of any small amount of liquid carried through the suction line from the evaporator.

When figuring the actual capacity of a compressor it is necessary to know the temperature of the superheated vapor that fills the cylinder. It is difficult to determine this accurately and it varies according to the type of compressor and the method of operation but in general a temperature of about 65 deg. F. is a fair average. As a difference of a few degrees makes little difference in the final results a temperature of 65 deg. can be safely used in most calculations operating engineers are called upon to make.

The figures giving the number of cubic feet per pound of the saturated vapor referred to very often as the capacity of the compressors will always be based on the volume and weight of superheated vapor. The same holds true for the figures in the 6th and 7th columns which give the density of the liquid and vapor at saturation temperatures.

Volume and weight of liquid and vapor must be considered by the manufacturers of refrigerating equipment as they have a very definite bearing on the size of compressors, condensers, evaporators and the connecting pipe work.

Heat of Liquid and Vapor

The next three columns of the tables are the most important for study by the operating engineer. These columns give the figures relating to the heat of liquid and vapor. The general heading is "Heat Content from −40 deg." This is then divided to give separate values for heat content of liquid, vapor and the latent heat. All values are in B.t.u. per pound.

In the next column it shows that it requires 73.50 B.t.u. to change a pound of this −40 deg. liquid into dry saturated vapor of the same temperature. This changing of state of a substance from liquid to dry saturated vapor is the latent heat of vaporization. The resultant dry saturated vapor will then contain or hold 73.50 B.t.u. which is known as the heat content of the vapor.

As the temperature of the liquid rises the amount of heat contained increases also and at a rate of about one fifth of a B.t.u. per pound per degree at the lower temperatures and one fourth of a B.t.u. at the higher temperatures. The heat content of the vapor also increases with temperature rise but at a slower rate than the liquid. The increase is about 0.12 B.t.u. per lb. per deg. at the lower temperature and 0.06 at the higher temperatures.

This shows that the power of carrying heat decreases as the temperature of the liquid and vapor increases. The latent heat or heat required to vaporize the liquid into dry saturated vapor, while the temperature remains constant, decreases as the temperature of the liquid and vapor increases. This decrease amounts to about 0.08 B.t.u. per lb. per deg. at the lower temperatures and about 0.20 at the higher temperatures.

The two columns of the tables under the heading "Entropy" will not be considered here for the values do not enter into any problems or calculations that concern the average engineer.

The tables of the properties of superheated Freon vapor are simple as there are but four columns and one of these is entropy and will not be discussed.

At the heading of the three columns is given both the absolute and gage pressure and the saturation temperature that corresponds to this pressure. In the column giving volume the cubic feet per pound are given for each 10 deg. temperature rise. The heat content is also given in B.t.u. per pound at 10 deg. intervals.

The increase in volume amounts to very little for each degree rise in superheat. At a gage pressure of 13.6 in. vacuum the increase in volume is only 0.011 cu. ft. per lb. per deg. At a gage pressure of 0.3 lb. the increase in volume is about 0.006 cu. ft. per lb. of vapor, and at 15.3 lb. gage pressure the increase is about 0.003 cu. ft. This shows that with increased pressure there is a decrease in the cubic feet per pound of superheated vapor.

This very small difference in volume per pound of the superheated vapor per degree means that a fair guess at the temperature of the vapor that fills the cylinder of a refrigerating machine will give very close to a correct figure in the calculations necessary to find the actual capacity. The established temperature of 65 deg. is close enough for general use.

FOR THE PLANT ELECTRICIAN

An Analysis of a Metering Situation

By C. O. von Dannenberg

WE ARE SO ACCUSTOMED to taking for granted the use of watt-hour meters as a standard application that we accept it as an essential feature without question.

It often happens, however, that instances occur where a review of the factors concerned bring to our attention details we have overlooked and which may seem of more than general interest and attention.

The particular situation in mind is that of measuring the input to a 3-phase, 60 cycle, 3500 kv-a., 2200 v. synchronous condenser which was used purely for voltage regulation and operated for extended periods with virtually full field, at so-called "zero" power factor.

The unit having been designed for this class of service has low losses, totaling 80-kw., which indicated an operating power factor of:

80/3500 times 100 or 2.29 per cent.

The unit, complete with all switching and switchboard facilities, was furnished by one contractor and the instruments included a polyphase watthour meter, of the 2 element type with two current and two voltage windings. So far as could be learned, the supplier of the watthour meter had not been informed of the service for which it would be used or that its calibration and adjustment for operating at low leading power factor was required.

The watthour meter was rated at 5 amp. and 100 v. per element and was connected to the 2200 v. circuit through 2000/100 potential and 1000/5 amp., current transformers, giving a capacity in terms of the 2200 v. circuit of:

2000/100 times 1000/5 times 2,
or 8000-kw.

It then follows, with the condenser operating at its full leading power fac-

Element	Element Angle Degrees	Cosine of Element Angle	Proportion of Total Energy Registered by the Element per cent	Relative Energy Values Kw.	Element Speed-Rotation R.P.M.	Element Speed in Per Cent Full Load Speed
W_2	88.71 — 30 = 58.71	0.5194	1332	1065	3.33	13.3
W_1	88.71 + 30 = 118.71	—0.4804	—1232	—985	—3.08	—12.3
$W_1 + W_2$		0.0390	100	80	0.25	1.0

tor condition, the meter was operating at 80/8000 times 100 or 1 per cent of its rating.

With a full rating meter speed of 25 r.p.m. the speed of the meter would be: 80/8000 times 25 or 0.25 r.p.m.

The foregoing indicates that the meter registration would be exceedingly low when furnished with a standard register, while in addition the friction factor at such a low rate of rotation might not be at all negligible even under the most favorable conditions of operation and maintenance.

A further review of the conditions, using a power factor of 2.29 per cent, gave results indicated in the following paragraphs.

The total energy of any 3-phase balanced circuit measured by a 2 element meter can be expressed as follows:

(1) $W_1 + W_2 = E.I. \cos (30 + \theta) + E_2 I_2 \cos (30 - \theta)$

Where W_1 and W_2 are respectively the energy registered by each element when the angle θ (a leading angle for this case) is that having a power factor of 0.0229 (angle 88.71 deg.). W_1 represents the energy registered by the element having the angle $30 + \theta$, while W_2 is the energy registered by the element with the angle $30 - \theta$. It is clear that W_1 is less than W_2 since the angle $30 + \theta$ is greater than $30 - \theta$ and correspondingly the value of $\cos (30 + \theta)$ is less than $\cos (30 - \theta)$.

We may write from (1):

(2) W_1 equals $E_1 I_1 \cos (30 + \theta)$

(3) W_2 equals $E_2 I_2 \cos (30 - \theta)$

Since the circuit is balanced $E_1 I_1$ equals $E_2 I_2$ we can write:

$$\frac{W_1}{W_2} = \frac{\cos (30 + \theta)}{\cos (30 - \theta)}$$

or in a more practical way we can state that the respective energies registered by W_1 and W_2 are proportional to the cosine values as indicated.

The values as calculated are summarized in the accompanying table.

The foregoing shows that the elements rotate in opposite directions, hence when mounted on a single shaft give the low resultant value of 0.25 r.p.m.

Perhaps the simplest and most direct way to increase the registration of the meter would be to introduce a register giving a ratio of 10 or even more to the reading. This would mean a constant was applied which had to be taken into account to reduce any reading to its true value.

As an alternative, however, which would overcome both the objections of a changed register ratio as well as the question of friction due to low rate of rotation, two single element meters could be used, even though somewhat greater space would be required and the tabulation given indicates the advantages gained as follows:

1. The speed in r.p.m. of the elements operating as single phase (one element) meters will be for W_1 and W_2 respectively 12.3 and 13.3 per cent of the full load speeds, in opposite directions, which will meet conditions assigned to standard limits of accuracy.

2. The registration of each meter will be an appreciable one for say a 12 hr. operating period.

3. No special attachments are required such as a special register ratio which if present always requires care in recording the true value.

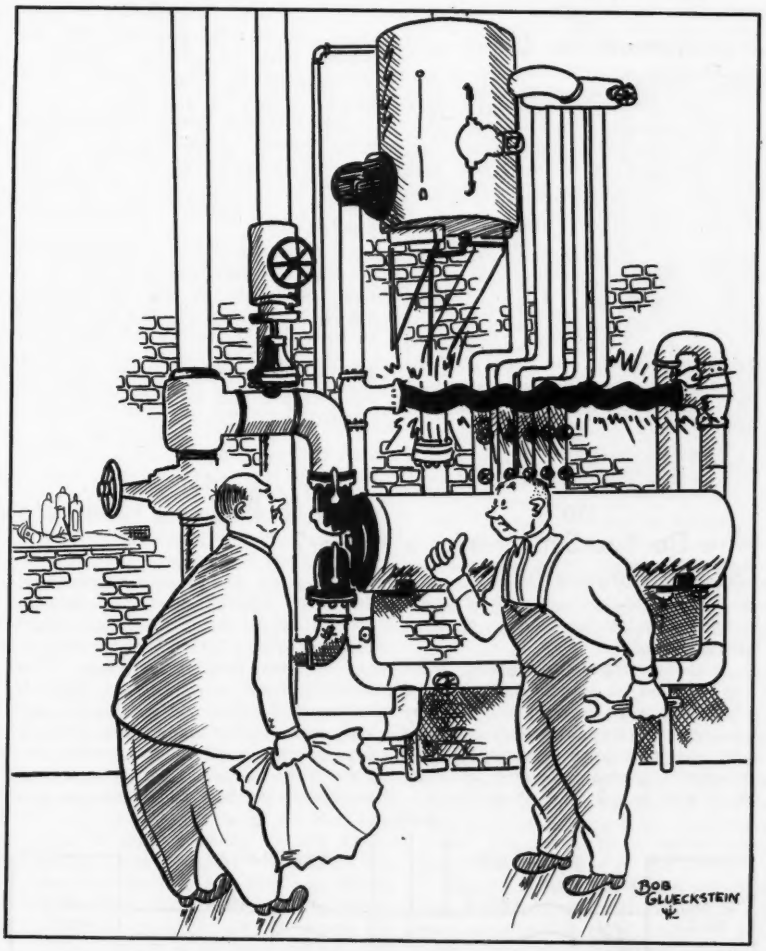
There are also some other features, secondary in a sense, but deserving of consideration.

4. When two single element meters are used it is possible to calculate at any time the power factor of the circuit from the ratio of the readings (see September issue, page 83).

5. It is also possible to detect at once should one of the meters cease to operate due to blowing of potential transformer fuse or other cause. (While modern meters have small indicating lamps to show the condition of the voltage circuit their addition is an extra item to be provided for.)

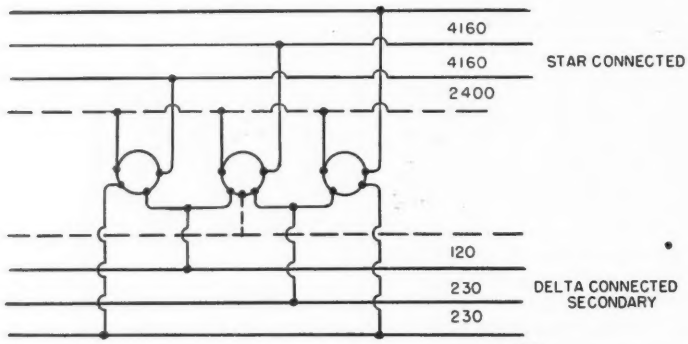
Using the value —985 for W_1 and 1065 for W_2 in conjunction with the formulas given in the article in the September issue, we obtain for power factor 2.25 per cent and for kv-a. 3550 which are good checks.

While it is not intended to suggest any method which might be termed an outmoded one or which has been superseded by something more modern in up-to-date equipment, the particular situation outlined where two single phase meters could be used in place of one polyphase meter, merits consideration, in view of the possible results available and their higher inherent accuracy.



"I hadda sorta jam that section in—It was too long"

Questions And Answers



WITH 15KW. POWER LOAD & 15KW. SINGLE PHASE LIGHTING LOAD WHAT WILL BE THE SIZE OF EACH TRANSFORMER?

NOTE:
ONE TRANSFORMER TO SERVE A LIGHTING LOAD ON SINGLE PHASE 3 WIRE SYSTEM.

129
Transformers for Light and Power

Q. I am submitting the accompanying diagram showing a bank of transformers, star connected on the primary side, delta connected on the secondary with a tap for single phase, 3 wire lighting on one transformer.

For example, take a 30 kv-a. power load and a 15 kv-a. single phase, 3 wire lighting load, and the high side of the units connected star to a 4160 v. circuit, 2400 v. to ground.

Question: What size should each transformer be and how would you calculate it? Also, what would the size of the units be if the connections were star to star?

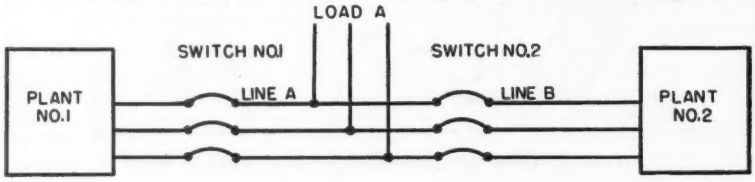
Opinions and comments by readers will be appreciated.

Birmingham, Ala. C. P. L.

130
How Do You Synchronize a Loaded Generator?

Q. I would like information in regard to practice in synchronizing a generator already loaded.

In the accompanying diagram, Plant No. 1 is used for standby. Plant No. 2 is in continuous operation. On rare occasions, however, switch No. 2 trips open and it becomes necessary to synchronize a loaded generator in Plant No. 1 with line B from Plant No. 2.



I understand the principle of synchronizing unloaded generators and am familiar with the technique involved in synchronizing an unloaded generator in parallel with other generators.

My question is this: In synchronizing a loaded generator with Line B, are there any difficulties encountered that are not met with in synchronizing an unloaded machine? All necessary instruments are installed.

If the power factor of load A is 80 per cent and lagging, and line B has a power factor of 80 per cent *leading*, would there by any difficulty encountered in synchronizing load A with line B?

Any help that anyone can give me in obtaining a better understanding of this situation will be appreciated.

Medford, Mass. JOSEPH J. ZLABIS.

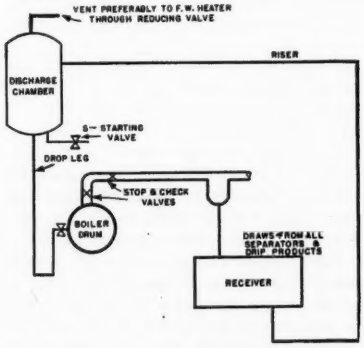
131
How to Repair a Concrete Floor?

Q. O. J. C., who lives in Illinois, not far from Chicago, has a maintenance problem on his hands and would appreciate help from those who have had experience along this line. He says: "The concrete floor in our power plant is in very bad shape, and we thought possibly some reader might know of some material we could apply to this concrete floor without the necessity of tearing up the floor and building a new concrete floor. We might also add that our present floor is not very level so in certain parts of the power plant it would be necessary to put more of whatever material we use than in other parts."

132
Help on the Holly-Loop

Q. A LICENSE examiner in Massachusetts has F. M. out on a limb and he needs help. He wants to know how to figure the size of the riser and drop leg of a Holly Loop for different size boiler plants, say 100, 250 and 500-hp.

For those who have forgotten the details of the Holly Loop, we show it in the sketch. It is used for automatically returning condensate and line drainage to the boiler. Drains from all separators are carried down to a receiver where they pass through a perforated plate so as to be broken into small drops. These droplets of water are then carried by steam through the riser pipe to the discharge chamber.



The pressure differential between the discharge chamber and the receiver, which causes the steam flow, is maintained by means of a small vent line. This should be led preferably back to the feedwater heater through a reducing valve. In the discharge chamber the water and steam separate, the water falling to the bottom and from there draining back to the boiler drum through the drop leg. Return flow is prevented by means of a check valve and water seal. The static head built up must be sufficient to overcome the pressure differential between the receiver and the boiler drum, as well as the pressure loss across the check valve. The loop is started by opening the valve S until steam appears.

A. 95
Two More Opinions on Relative Corrosion of Hot and Cold Water

A. Regarding H. J. Moore's inquiry as to the relative corrosion in hot and cold water, quite an article could be written on that subject because there are so many ways of looking at it.

All chemical reactions occur more rapidly in hot solutions. At the same time when it comes to the use of water

where the corrosion is due to gases rather than mineral impurities there is also the chance that heating, if accomplished vigorously, will liberate and remove the gas so that sometimes hot water lines will show less action than one might expect. However, it would be my opinion that black iron would be preferable to galvanized in case there is a corrosion problem, because as a galvanized line begins to corrode and the galvanizing film is broken, then other types of reactions can bring about electrolitic corrosion sufficient to remove the balance of the zinc. I would imagine that unless the water is quite corrosive that black iron for the cold water pipe would be perfectly satisfactory. I have a suspicion, however, although it is not mentioned in the question, that they are planning to soften their laundry water because laundries usually do soften with zeolite, in which case we have a different problem altogether.

Winnetka, Ill.

DUDLEY K. FRENCH.

A. In question No. 95 in the February issue of POWER PLANT ENGINEERING, you ask which line to put in the laundry, copper or galvanized.

I am chief engineer of a large laundry here in Saginaw and we use 90,000 to 100,000 gal. of water a day, cold and hot, which gave us a lot of trouble because Saginaw has the worst water in the country.

Our hot water tanks which are made of steel are lined with cement as there are a million pock holes in them and so we just cemented them up and they hold up very well, about 10 yr. this has been in now, but the small heater shell is so thin now that we are replacing it this March.

Our washroom lines could never be kept from leaking as the jar from the automatic valves would set up in the connections and severe leaks would develop. In addition the water corroded the pipe so badly that they had to be replaced entirely every 5 yr. that is galvanized pipe.

Well, it sure gets you down changing pipe all the time so when one of the large breweries went out of business we bought all of the copper pipe from them and put both our lines in in. copper.

But as bad as the water is here, our cold water didn't give us any trouble and they could have remained in service as some of these lines had been in 15 yr. and were still good.

I would use **just** the copper pipe on the hot water lines and use galvanized on the cold. I don't think you will have any trouble after that.

As our water went into closed heaters and was not deaerated we got CO_2 in the water which caused all this trouble, but to deaerate the water would have cost a great deal so we solved the trouble by the use of copper pipe.

Saginaw, Mich.

RUDOLPH KRAATZ, JR.

A. 96

Manhole Plates and Gasket Surfaces

IT SEEMS to me that the failure of D.H.W.'s cover plates to hold under pressure, as noted in February P.P.E., is not the fault of the plates, but rather an elusive condition existing between the plates and the mating surface on the seat or boss of the boiler head. Although it is hardly likely, it is possible that the gasket material he is using is too thick or of very uneven thickness. A gasket for any purpose should be as thin as possible while still resilient enough to yield and recover under the expansive and contractive effects of temperature change in the boiler metal taking place under pressure. In general, the higher the boiler temperature and pressure the thinner the gasket should be.

While poor gasket material may cause a joint to leak, this source of leakage may be discounted in D.H.W.'s case. Rather the cause should be looked for either in the misalignment or improper surfacing of the seat or yoke, or both. Since more than one plate leaked, and leakage continued after the plates were resurfaced, the mating surfaces on the boiler may be uneven, either from patches of old gasket clinging to and hardened upon the surface or from irregular scraping off procedure. Or the whole yoke may be warped. Many boilers have a peculiar habit of stress relieving themselves by relieving the stress in any old direction. While suggesting these possibilities as the cause of the trouble, I am ready to gamble that the leakage is caused by the surface on the boss being too smooth from much scraping off of old gasket material or hardened graphite.

As a rookie doing maintenance work in a power plant a dozen years ago, I was given the job of overhauling all traps in the plant as well as those outside on the various steam lines. After cleaning out sludge, rust and scale and renewing plungers and seats of the first trap I tackled, I decided to resurface both trap and cover plate in a lathe. Having been a machinist and having an eye for the shine of a smooth finish on metal, I decided to make an A-Number One job on the machine. After knocking off the high spots I used a round nose gouge in the tool holder and set the lathe to the finest feed. The result was a smooth surface which contrasted sharply with the raw surfacing jobs I had noticed on new traps. I was immensely proud of my work —until I put the trap on the line. Also, I made sure of a snug fit by miking the gasket, rechasing the threads on studs and nuts and lightly lubricating the threads when assembling the trap. Besides, I locked the trap in a vise while bringing the nuts down hammer tight. Yet at 150 lb. she blee-ew! Almost cutting my leg in two midway between ankle and knee.

My pride in the job blew with the gasket. I just couldn't understand it. All my painstaking work gone to blazes. I called an old timer into consultation. After inspecting the trap, which I had disassembled, he laughed. "You're trying to make too nice a job of it," he said. "You'd have to put teeth all over a gasket to make it hold on a smooth surface like that. Put her back in the lathe and rough her up, Buddy. I mean rough 'er up!"

I took the old timer's advice and roughed her up. The gasket held perfectly. As other traps came up for repair, I resurfaced them, too, roughing them up as advised by the old timer. Not one of them blew, even though there were times when I had to use the old gasket or cut new gaskets from inferior or in appropriate material. Since that time I have resurfaced hundreds of pipe flanges, trap covers, pump head covers, etc., which are sealed by gaskets. I have tried various ways of doing this, using lathes, planers, shapers and milling machines. The last three machines seemed best for square traps and covers—until I tried them. The lengthwise grooves along the sides parallel to the stroke of the machine held well. But the grooves across the ends tended to allow slight seepage and required excessive tightening of the nuts on the end studs. Now, if I have a resurfacing job I do it in a lathe. On the finish cut I use a sharply pointed tool set about five to ten thousandths deep and with a sixteenth to thirty-second feed.

On the mating surfaces of these cover plates, except in the case of traps, which were small enough to machine, I had to use the kind of technique D.H.W. should develop, namely the hammer and chisel and scraper kind, with appropriate movements of the elbows and wrists. First, with a straight edge and flashlight or bulb on a drop cord I determine how true the surface is and find any bumps of hardened gasket or graphite. If the surface has been warped or perhaps cut by a too sharp chisel used as a gasket scraper by a too zealous maintenance man in times past, I ascertain the damage and what to do about it. A deep chisel gash at right angles to the mating surface may nullify the effect of the whole gasket. With careful scraping, however, the surface may be smoothed down to the level of the groove bottom without the necessity of refacing the whole surface.

Once the surface has been trued roughing it up is simple. A hammer and a sharp chisel are the only essentials. On occasions a center punch may take the place of the chisel.

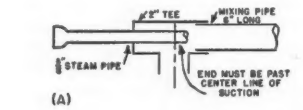
Before blaming the covers which are apparently properly surfaced and in correct alignment, D. H. W. ought to make sure of the surfaces against which they mate.

GEORGE HOLMAN.

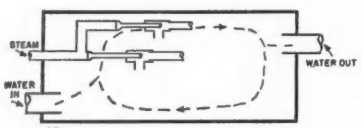
A. 109

Another Scheme for Reducing Noise in Heaters

A. Mixing steam and water may best be accomplished by using the syphon jet principle. A sufficient number of jets made of pipe fittings arranged so that circulation results will do the job quietly. The jets can be made as shown in the sketch (A). Use



(A)



(B)

as many of such jets as are necessary to handle enough steam. Placing them in the heater is more of a problem than making them as there should be circulation. One way is shown at (B) but P.G. will have to work out the best arrangement for his particular conditions.

Jefferson City, Mo. F. HECKMAN.

A. 111

Detailed Instructions for Making Transformer

A. On page 92 of the April issue W. B. Laughinghouse requests information concerning the construction of a transformer to deliver 40 amps. at 4 v. when the primary is placed across a 110 v. 60 cycle single phase line.

The calculations of any magnetic circuit are, necessarily, complicated because the magnetic flux cannot be confined to a definite path, and the permeability of the magnetic core material varies with the density of the flux within it. Certain empirical values must be used in the practical design of any transformer. The accepted value of flux density allowable in the average type of iron core transformer may be taken as 50,000 lines per sq. in. of cross-sectional core area. The "E" shape shell type of core will be assumed in this design as this is the most popular and efficient core shape. The area used in all calculations is the cross-sectional area of the middle leg.

The first step is the determination of the core area. The total flux is equal to the flux density times the area of the core, thus:

(1) $\emptyset = B \times A$ $\emptyset$ = total flux, maxwells; B = flux dens., lines/sq. in.; A = core area, sq. in.

A factor C is employed to give the relationship between total flux and the ampere-turns. This empirical factor is used as follows:

(2) $C = \dfrac{\emptyset}{N_p I_p}$ N_p = no. turns on pri.; I_p = pri. current, amp.

The number of turns on the primary is not yet known, but the turn ratio between pri. and sec. which is the same as the voltage ratio, is known to be 110:4. The ratio of pri. current to sec. current is the reciprocal of the turns ratio, thus for 100 per cent efficiency the formula becomes:

(3) $\dfrac{I_p}{I_s} = \dfrac{4}{110}$

With the sec. current as 40 amp. and taking an efficiency of 90 per cent, the primary current is found to be 1.7 amps. The average value of the turns per volt per square inch of cross sectional area is about 7.5. This expressed mathematically becomes:

(4) $N_p = \dfrac{7.5 \times E_p}{A}$

It is now possible to substitute the values of the terms into equation (2):

(5) $C = \dfrac{\emptyset}{N_p I_p}$

$$= \frac{B \times A}{\frac{7.5 \times 100}{A} \times 1.7} = \frac{50{,}000 \times A^2}{7.5 \times 110 \times 1.7}$$

A representative value of C can be taken as 335 for an air cooled (natural draft) transformer. Equation (5) then becomes:

(6) $A^2 = \dfrac{7.5 \times 110 \times 1.7 \times 335}{50{,}000} = 9.4$

$A = \sqrt{9.4} = 3.06$ sq. in.

A core 1¾ by 1¾ in. would have the required area of 3.06 sq. in.

Using the value of area thus obtained in equation (4) the number of turns on the primary can be computed:

(7) $N_p = \dfrac{7.5 \times 110}{3.06} = 270$ turns

Since the turns on the sec. have a definite relation to the turns on the pri. ten turns will be needed on the sec.

The size of wire to use in the windings is determined by the current flowing in the respective windings. The general practice allows 1 ampere of current per 1500 circular mils for continuous service. Using a wire table with the known values of pri. and sec. current, the wire size was found to be 16 ga. B. & S. for the pri. and 2 ga. B. & S. for the sec.

The window area to accommodate the windings must be calculated before the exact size of the laminations can be specified. The space required for machine wound coils for various wire sizes are tabulated in most wire tables. For No. 16 wire the number of turns which can be wound in 1 sq. in. of window area is found to be 271, which is practically the same as the number of turns required. Ten turns of No. 2 wire would require about .71 sq. in. The total of these two areas is 1.71 sq. in. The true window area is obtained by increasing the value by 50 per cent to allow for hand winding and the placing of insulating sheets between the layers of the windings. This makes the required window area equal 2.56 sq. in.

The primary and secondary windings should be wound on top of each other with the pri- next to the core.

WAYNE G. SHAFFER.

Minneapolis, Minn.

A. 117

Use of Steam in Atomizing Burners

A. As stated in the June, 1941 issue, by using a small amount of steam with mechanical oil burners, Edward H. Goebel observed that the operating efficiency was improved in spite of the fact that one might expect a slight loss due to the heat absorbed by the added water vapor and carried from the system. He was told that the increased efficiency was due (a) to increased turbulence of the furnace gases with consequent better combustion and (b) to the dissociation of the water vapor into hydrogen and oxygen and that the burning of the hydrogen, as if it were an additional fuel supplied free of cost, accounted for the increased efficiency.

It long has been common knowledge among combustion engineers that the heat required for the dissociation of water vapor equals the heat released by the burning of the hydrogen and oxygen thus obtained. In other words it is not possible to obtain something for nothing. Furthermore, it is doubtful if there would be any dissociation of water vapor at a temperature as low as 2200 deg. F.

Haslam and Russell in their book, "Fuels and Their Combustion," pages 288-289, state that at temperatures above 3000 deg. F., CO_2 and water vapor are slightly dissociated. Curves are given showing percent dissociation plotted against temperature. For water vapor at 0.1 atmosphere partial pressure the following figures are shown:

Percent Dissociation	Temperature Deg. F.
0	2800
10	4100
20	4650
30	5000
40	5400
50	5750
57	6000

It is obvious, therefore, that even if Mr. Goebel reduced his excess air to a practical minimum he probably would not get a furnace temperature over 4000 deg. F. which would give less than 10 percent dissociation of the water vapor. Furthermore, as previously stated, the amount of heat liberated by the burning of the hydrogen produced by the dissociation is completely offset by the energy required for such dissociation, even if we assume no radiation losses.

Naperville, Ill. J. R. DARNELL.

LETTERS AND COMMENTS

On the Calculation of P.F. for 3-Phase Unbalanced Loads

IT IS GRATIFYING to note the interest indicated by Mr. Tinker's article, in the August 1941 issue, concerning the writer's formulae derivation in the February 1941 issue.

The original article printed in the September 1940 issue stated its purpose clearly in the first paragraph as being applied to routine tests only to certain particular equipment, hence any comments concerning possible shortcomings or errors involved if used for "billing" purposes are obviously beside the point or outside of the scope of the initial text.

It is odd that in Mr. Tinker's article continued use is made of the tangent formula for obtaining power factor, involving the use of a trigonometrical table when the result could have been calculated directly from the formula given in the September 1940 and February 1941 articles.

The reason why text books and other sources do not give specific limitations to the use of the formulae concerned is due, for the most part, to the number of variables involved. To be strictly correct for any condition we must consider three voltages, three currents and three phase angles, all of which have a definite bearing on the result, so it is readily seen how complex the matter may become.

The comments by Mr. Tinker draw attention to and bring to the fore the inherent shortcomings in our commercial methods of metering. Mr. A. E. Knowlton in his book "Electric Power Metering," Mr. G. W. Strubbings in "Commercial A-C Measurements" and other writings, and Mr. Boland in recent issues of the General Electric Review, have treated the subject of Reactive kv-a. (kilovar) measurements exhaustively. Actually the results obtained are the closest available with standard commercial equipment available and may err on the "low" side and so result in values of financial advantage to the customer.

Strictly speaking, the true RKV-A measurement should include a current combined with a voltage 90 degrees out of phase with the normally associated voltage used for the KW measurement. What we actually do have in our standard commercial application is a modification consisting of a voltage at approximately 90 deg. which is the vector sum of 57.7 per cent of the former associated voltage plus 115.4 per cent of another voltage not originally associated with the current concerned. These voltages are obtained from auto transformers with suitable taps. It is clear, therefore, that the resultant voltage used in the RKV-A meter is thus subject to auto-transformer errors plus angular and other errors.

Strictly speaking, the use of methods as standardized and officially sanctioned is justified even though we may know certain discrepancies are possible. On the other hand, the methods described in the September 1940 article had a definite application for a specific purpose and are well worth using for this purpose due to their simplicity and the minimum of equipment required. While at the same time the readings obtained are in themselves accurate. While the calculated results may have discrepancies, their possibility is limited to two pieces of equipment and when used for routine tests will always give the same relative results to serve as direct comparisons.

Actually tests made using three wattmeters, three ammeters and three voltmeters, using the line to neutral voltage for the voltmeters and the potential coils of the wattmeters, did not, for the application, indicate sufficient difference to warrant the additional effort and equipment.

The statement in the second paragraph is definitely justified through actual experience and as stated has no direct bearing when the question of "commercial" billing is involved.

Brooklyn, N. Y.

C. O. von Dannenberg

He Thinks Our Units Are Nuts

Dear Editor:

Like nearly every one else I like to "beef" now and then. In working with power production, air conditioning, electrical distribution, and a little chemistry for the past number of years it has been apparent that the fields are over-lapping a little more each year. The units of conversion are also becoming increasingly more inconvenient to use. For instance in air conditioning a horsepower motor gives off a certain percent in radiation and the horsepower is converted to the desired B.t.u., but a 60 watt light bulb requires a change from kw. to B.t.u. A power house buys B.t.u. converts to boiler horsepower, to kw. and the factors are 33,450 and 3412 to 3415 take your choice of authorities. A boiler horsepower is equal to some 33,400 B.t.u. per hour and a horsepower is 33,000 ft. lb. per min., now isn't that just ducky.

Continental Europe and our own scientist have adopted the metric system and have it all over us so called practical men. What's practical about inches, feet and miles that give factors of 12, 31, and 5280? What's practical about grains, ounces, pounds and tons when you have to use multipliers like 7000, 16, and 2000? What's practical about a horsepower with 550, 778, and 33,000 for factors? And what in the world is the sense to a kw. that has an odd relation to everything?

It is possible to secure a nearly distilled water at any place so why should'nt we adopt some system of weights based on water like the metric system. Then bring our heat and electrical units in to match. According to our present practice a kw-hr. is equal to 3412-3415 B.t.u. per hr. or about 780 kilogram calories. Even in the metric system that is a bad relationship, so why not change the electrical units. A volt, an ampere, and an ohm are all arbitrary units with a definition that could easily change. There is nothing magical about 2300 or 4150 v. Even household flashlights have odd voltages like 2.4 and 3.5 and light globes of 11.4 volts. Why? Gear ratios in integrating meters would have to be changed and lots of meters have new faces but nothing else.

Hard to make the change? Yes, I suppose so, but not nearly so hard as trying to teach and remember the odd type constants for the conversions of English measure. We are and have been bull headed, we are supposed to have won the Revolutionary War but we are still under the English weight and foot. If we are to run a practical business under a practical government, let us adopt a practical system of measurements.

BILL MADDOCK, M. E.

How Would You Do It?

Lots of our readers seem familiar with the laundry business, at least that is the impression we get from the solutions to Problem 17. Mr. Christenson's problem of getting hot water, apparently, is the most common of all laundry problems and while it is a difficult one, there seem to be many ways of solving it

PROBLEM 17
HEATING WATER FOR A LAUNDRY

WRITES OUR FRIEND, Harold Gethoefer of Buffalo, N. Y., "Say, what's happened to "Our Hero"? Boy, how I miss that guy! You know, somehow he makes my job seem easier. When I read over some of his headaches I can really relax and say, Well, someone else gets all jammed up too. Then I sit right down and start to worry for the both of us. Now, for the past 2 mo. the guy don't have a breakdown, or a new installation, not even a leaky valve. How come, is he on a vacation? He can't do this to us. He must have some headaches to pass on to us, so call him up, won't you?"

Well, can you beat that? Here is a man actually asking for trouble—a bona fide subscriber of ours, too. When we handed the letter to our Board of Judges they looked at one another, funny, over their long whiskers and shouted, "Hooray, this guy is nuts too —he should become a member of the Board."

And don't worry. Our Hero isn't lost. True, he has been on a vacation but as far as we know he has not passed up any headaches. "What about the laundry problem in the July issue, Mr. Gethoefer? Didn't you see that on page 97? Maybe you don't call that a headache, but if you were Mr. Christenson and found yourself with 6 tons of dirty laundry on the premises and no hot water to wash it in, you would think it was a headache, no fooling."

Such a situation might not faze such a versatile genius as Pulverizer Pete—he would quickly suggest sending the mess to the local Asiatic—but to Mr. Christenson it is a serious situation and that is why he asked "Our Hero" for help.

Our Hero, with characteristic finesse, promptly evaded all responsibility by going on a vacation and passed the buck to us, and thereupon, also characteristically, we passed it on to you, dear readers—God bless you!

Unlike a number of other headaches that Our Hero has passed on to this department this particular one has no specific solution because not enough is known about the plant in which the situation arises. Certain general principles can be adhered to in considering a problem of this kind and in the absence of specific data the contestant is privileged to make assumptions by means of which he can suggest one or more courses of procedure.

It was this sort of detached, yet very logical consideration of the problem which easily won for Mr. Sibley the leading award in the contest. For once the Board of Judges was able to act without days of quibbling and without coming to blows.

Before we present the prize winning letters attention is directed to a slight error in the statement of the problem. It was stated that a Schwab boiler return system is installed in the plant. This should have read Schaub, since it is the system made by the Fred H. Schaub Engineering Co. of Chicago.

First Prize Award
E. F. Sibley
East Hanen, Conn.

Heating laundry wash water by the direct injection of live steam into the washer is unquestionably the most expensive way of operating. For the maximum of economical operation there are many interrelated problems which require careful analysis.

The washing of linen is a chemical as well as a mechanical process. While some of the dirt must be removed in cold or warm water to prevent it being set or cooked into the goods, most of the sudsing and rinsing is speeded up with hot water. In connection with cold or reduced temperature washing consideration should be given to the reduced wear and tear on the washed goods as well as the more efficient operation of a smaller wash room where fewer machines are required to turn out the same volume of work.

The reason the writer is bringing up the question of washing formula is because he has found that in many laundries the hot water requirements run between 60 per cent and 80 per cent of the total water used instead the 30 to 40 per cent as estimated in the problem.

A recording thermometer located in the wash room trench will help in estimating present average water temperatures. This should be checked against the washing formula and number of runs.

No mention is made in the problem as to the availability of exhaust steam although this is one of the major factors in laundry water heating. If power is not now being purchased well under one cent per kilowatt-hour, consideration should at once be given by the laundry management to making their own power. In passing steam through an engine, sufficient power can be obtained to operate the plant and in the exhaust steam from the engine there will be almost as much heat for water heating as there was originally. If the steam is charged for on the basis of the power generated the water heating will cost close to nothing.

The amount of exhaust steam available or computed from the water rates of the engine will for the power load determine the amount of heat to reclaim from the waste water by means of a heat exchanger. This is the third item to consider. The salvage of heat otherwise run to waste down the sewer must be balanced against investment charges and the amount of exhaust steam which is or will be produced. With a given power load an engine with a low water rate will save steam and fuel costs but will require a larger investment in both the engine and the heat reclaimer. On the other hand, it may not pay at this time to scrap an uneconomical engine just to reduce fuel costs. Just how this is a problem in the availability of equipment for non-defense purposes.

The next item to consider is storage. As the cold water supply is stored in tanks not under pressure, it is logical to accept an open wood stave tank for hot water storage in place of the more usual closed storage heater. The wood tank is non-corrosive and does not use defense material. The size should be sufficient so that water can be heated as reclaimed and as exhaust is available with a reserve to carry through the washing cycle. The size will depend on the type, size and number of washing machines, washing formula and the rate and variation in rate at which work is put through the plant as well as the characteristics of the power load. With the information available one can only guess between 3000 and 10,000 gal.

In a hard water district where water softeners must be used, it is desirable to return to the boilers as much condensate as possible. This calls for a closed type water heater, an efficient oil separator properly located in the engine exhaust line. Full pressure drop of the cold water through the water heater will permit high rates of heat transfer in a compact unit.

Live steam can be used to supplement exhaust when starting up a cold plant and for boosting capacity when exhaust lags on demand.

The pumps to be used between the water storage tanks and wash room should have sufficient capacity to take care of peak demands. This may be three or more times the average hourly requirements. To maintain constant pressure they should have so called flat top characteristics.

While it is usually realized that low water pressure is a hindrance to efficient wash room operation, the full significance is not often realized. Operating a washer without water increases wear and tear on the goods and the machine. Every minute lost in filling with water between the various suds and rinses is lost time. The writer has found that with good water pressure productive labor in the wash room could be cut from 10 to 50 per cent and one washer out of five eliminated, floor space saved and investment cost reduced in the same proportion.

Second Prize Award

Andrew C. Elder
Los Angeles, Cal.

Let's look at Our Hero's problem from a practical view point. In the first place he has to heat water; second, he has steam to heat it with, and he wants to know the most economical method to heat it. Taking his figures of 60,000 gal. per day, my experience has proved that when hot water is available to the wash room, 50 per cent of the total water used will be used for hot water. This brings us to a concrete figure of 30,000 gal. per day. Assuming his wash room operates 8 hr. per day, we have an hourly total of 3750 gal. As a rule most laundries have at least 100 lb. steam pressure and we want to talk about that first.

Most people seem to think that the heating power of steam is in proportion to its pressure. This is not the case, low-pressure steam carries almost as much heat per pound as 100 lb. pressure steam does. For instance, a look at our steam tables show that 1 lb. of steam contains 1150 B.t.u. and 100 lb. steam 1188 B.t.u., or 38 B.t.u. more. At present he is using this steam directly in the wash wheels. 1 lb. of steam at 100 lb. gage would bring in 1188 heat units and liberate enough heat to raise each 1000 lb. of water 1.16 deg. 1 lb. of steam at atmospheric pressure would bring into the wheels 1150 heat units and liberate enough heat to raise each 1000 lb. of water 1.11 deg., assuming that the water and other contents in the wheels were at 70 deg. To get this low-pressure steam to the wheels would naturally require larger piping than is required for the higher pressure. The next step to consider is a heater and we have two types to choose from, open or closed. In the first, the water and steam are mixed together, the steam is condensed and becomes part of the water; the second, or closed heater, the steam passes through coils and the condensate must be drained off separately, it does not mix with the water and the heat of the condensate is lost.

There is an old formula for this which is as follows:

$$S = \frac{W(T-t)}{H}$$

S = weight in lb. of steam required.
W = total final weight of hot water required.
T = final temperature of water required.
t = initial temperature of water to be heated.
H = total heat in the steam computed above the initial temperature of the water to be heated.

Most laundries want a hot water temperature of 180 deg. Applying this formula we have

$$S = \frac{3750 \times 8\frac{1}{3}\,(180-70)}{1150} \text{ or}$$

$$\frac{31{,}250 \times 110}{1150} = 2989 \text{ lb. steam per hr.}$$

when an open heater is used.

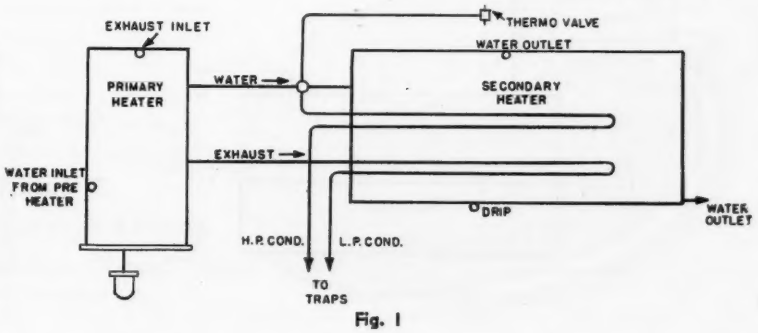
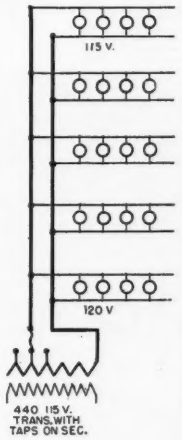


Fig. 1

PROBLEM 18
UNEVEN VOLTAGE DISTRIBUTION



A rather annoying situation has developed on the lighting circuits in one of the buildings in Our Hero's plant. In a 10-story building all the 115 v. lighting circuits are fed from a single pair of vertical feeders as shown in the diagram. It is an old installation and years ago when less attention was paid to illumination levels than is the case now, 60 watt lamps were used but now most of these have been replaced with 100 watt units. While the additional load does not particularly overload the feeders, there is about a five volt drop across them from the top floor to the transformer in the basement. As a consequence the lamps on the lower floors burn more brightly than those on the upper floors. About a year ago Our Hero tried to solve the trouble by buying 120 v. lamps for the lower floors and 115 v. lamps for the upper floors but this proved a nuisance and now he is wondering how to effect a better solution. He would like all circuits to have exactly the same voltage. The 440/115 v. transformer has taps on the secondary so that it can furnish a variety of voltages between 110 and 130 but changing the voltage of the secondary winding does not alter the relative voltage distribution. So what to do, that is the question. A number of things can be done but the idea is to effect the best solution with minimum expense and effort.

Write out your opinion of this problem in a letter of not over 1000 words and send it to the Contest Editor by September 25. A first prize of $15 will be awarded for the best letter, a second prize of $10, and a third prize of $5. Entries should be addressed to the Contest Editor, Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill.

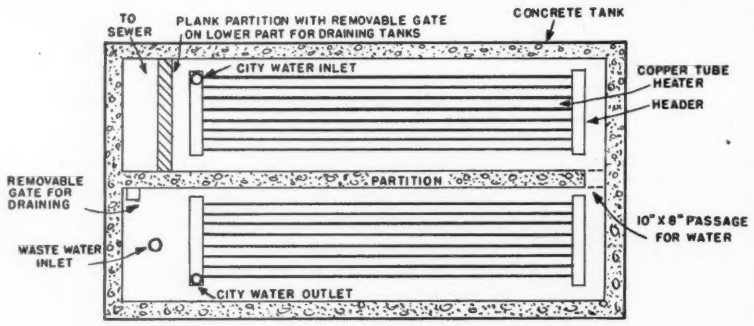


Fig. 2

If we apply this formula to a closed heater, the heat of the condensate above 32 deg. must be subtracted from the total heat of the steam. The steam is at a temperature of 212 deg. or 180 deg. above 32. Subtracting 180 from 1152 we have 972 as the value of H when applied to a closed heater, or the value of S would be 3536 lb. steam per hr., and is approximately 15 per cent more steam than required in an open heater. If any exhaust steam is available it can be used in the open heater and it would reduce the amount of high-pressure steam required. If high-pressure steam (100 lb.) is used in the open heater, the amount necessary would be 2893 lb.

Heating water in the wheels is a poor job at the best. In the first place tests have proven that from 12 to 18 per cent of the steam used is wasted, it blows through both the water and clothes, in the second place it is almost impossible to maintain an even temperature, and last, but by no means the least, it takes from 10 to 20 min. longer to get the same results.

The most economical method to eat the water is by installing an open heater, storage tank and oil extractor combined. This way all the exhaust steam can be used and through a thermostate, using only what live steam is required to maintain the desired temperature. It will speed up the washroom and reduce boiler room cost.

Laundry steam loads are divided in two classes: First, steam to heating units such as presses, ironers, dry rooms, tumblers, etc.; second, hot water heating. The first is fairly constant inasmuch as the machines are operating continuously during the day, but the hot water load is a series of instant demands and for this reason, water should be heated to the proper temperature in a heater where the storage is large enough to take care of these demands and eliminate sudden demands on the boiler.

The writer has installed this system in laundries with a hot water demand of 30,000 gal. per hr. In the heater we had a storage of 8000 gal.. at times this storage would be reduced to as low as 3000 gal., but we had a steady flow of cold water entering the heater and being heated before it reached the storage chamber. Our steam flow charts did not vary 5 lb. during the entire day until late in the afternoon when part of the washroom was shut down. At this time the line on the chart materially dropped. We used the Marco Heater which is made in Ohio and is made especially for laundries. This heater delivers to the washroom unlimited quantities of even temperature water to meet all demands and is so efficient that it pays for itself in 2 yr. in steam saving and increased washroom production. The same machine did 25 per cent more work when hot water was available at the wash wheels.

Third Prize Award

Charles Magnus
Ogunquit, Maine

It is not stated, but I presume that Mr. Christenson is running one or more engines to operate the laundry and can use his exhaust steam for heating the water.

I had practically the same conditions—a 150-hp. engine, a primary heater and a combination storage and secondary heater with one high-pressure and one low-pressure coil connected to two return traps, discharging to two boiler return traps placed 40 ft. above the heater. Condensation from the primary heater went to the sewer because of oil. Temperature of water in the secondary heater, 180 deg. F., was regulated with a thermostatic valve. (Fig. 1.)

I put in a two-pen temperature recording gage, one pen connected to the city water, and one to the waste water from our washroom.

We found that it would be a good investment to take the heat out of the waste water.

We installed two copper tube heaters connected together in two concrete tanks level with the boiler room floor. City water passing through heaters reverses to waste water passing through the concrete tanks to sewer. (Fig. 2.)

We raised the temperature of incoming water at an average of 50 to 60 deg., with the result that I shut off our thermostatic valve entirely, and got away with it.

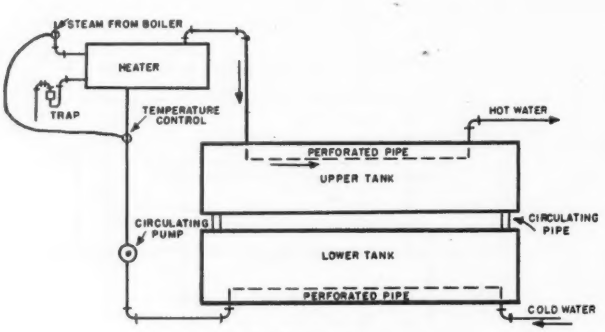
The whole installation, I figured, paid for itself in 3 yr. bricks easing up on the boilers. I washed the copper tubes off twice a week with a fire hose at 150 lb. pressure. It is also important to make the concrete tanks large enough to let the water travel through at a very slow rate.

I left 18 in. space around the heaters for taking out heavy dirt.

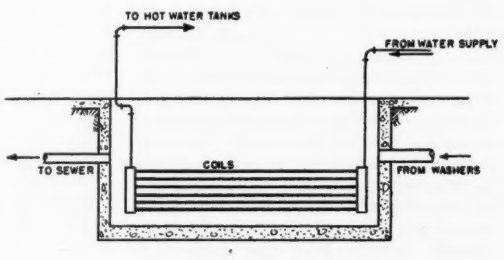
Honorable Mention

It was interesting in the analysis of the various solutions to note that many other beside Mr. Magnus suggested the use of a heat exchanger to recover the heat in the waste water to the sewer. The arrangement proposed by James O. G. Gibbons in Fig. 4, it will be seen is almost identical with that suggested by Mr. Magnus in Fig. 2.

Mr. Gibbons does not believe that the use of an instantaneous heater is advisable. "It may be said at the outset," he writes, "that instantaneous



WATER HEATER & TANKS
Fig. 3



HEAT EXCHANGER
Fig. 4

IF YOUR FEEDWATER LINES WERE *Glass..*

would th
look lik
this...
Softened boiler feedwater at 200° F. was run through tube at right continuously for one hour. Incrustation in tube weighs 137 milligrams.
Photos in Nalco Laboratories
or like
this...
Same feedwater, at same temperature, treated by Nalco to prevent incrustation and circulated through tube at left for one hour. Incrustation weighs only 1 milligram — less than one percent of former deposit!

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heating does not lead to good overall economy, as sudden demand on the boiler tend to lower the efficiency at that point; in fact, as a general rule, the best boiler efficiency can be obtained when the steam demand is kept constant.

"One of the great difficulties in maintaining good boiler efficiency in laundry plants is caused by the fluctuating demand for steam and hot water.

"The sketch herewith (Figs. 3 and 4) illustrates a method of evening up the steam demand, while at the same time insuring an adequate supply of hot water to take care of sudden demands, and it would appear that the two 18,000 gal. tanks which Mr. Christenson now has might be rigged up to take care of his requirements very nicely.

"I believe that certain patents were issued to Mr. L. L. Ransom of New York covering the kind of arrangement illustrated, but I do not know whether they are still in force, or exactly what is covered by them. The chief thing, however, is to as far as possible keep a constant amount of cold water circulating through the heater so the demand for steam will be constant.

"Savings can also be made by running the waste wash water through a heat exchanger, by means of which a certain amount of preheat can be given to the fresh water before it goes to the heating tanks.

"The sketch (Fig. 4) shows the general method of doing this."

Harold Brown of Lombard, Illinois feels the same as Mr. Gibbons in regard to the use of an instantaneous heater. Quoting from his letter,

"I believe Mr. Christenson should endeavor to spread the loads on his boilers rather than put on a heavy load by using instantaneous heaters. If the hot water is used continuously throughout the day instantaneous heaters would be quite satisfactory, but if the hot water was used over a 4-hr. period it would mean a considerable increase in boiler load."

"20,000 gal. of water in 4 hr. would be 5000 gal. or 41,666 lb. an hr. which would require 4,999,920 B.t.u. to heat it from 60 to 180 deg. F.

"At 60 per cent furnace and boiler efficiency and 12,000 B.t.u. coal, this would require 695 lb. of coal an hour."

"Most any of the steam coil heaters are efficient as far as heat transfer but the time required to heat water will depend on the design, if the coils are kept clean and if the traps are working properly.

"I would suggest that Mr. Christenson install a counterflow heat exchanger in his waste lines (if he does not have one already) with a small circulating pump connected to the tank supplying the hot water heaters. If the incoming water in the laundry could be heated to 90 or 100 deg. F. from the heat in the waste water about one-third of the fuel for heating water could be saved.

"If all of the exhaust steam in the plant is not being used he should install enough hot water heater and storage capacity so that the exhaust steam could be condensed and much less live steam would be required for heating water."

Another splendid letter deserving honorable mention is that submitted by William T. Mullen of Philadelphia as Engineer of the Pennsylvania Laundry and Supply Co., he writes as follows:

In the plant where I am at present, which is a laundry and linen supply, we had some trouble with hot water, until we installed another tank for the use of storage and circulation of the hot water from the original hot water tank, the original hot water tank has the heating coil and exhaust steam from our engine goes through this coil and gives up its heat, this exhaust steam takes care of all hot water in the summer season. But in the winter some live steam is added to bring the temperature of the water, which we have found by experiments, to be as good as can be successful in the proper washing and rinsing of clothes. This control of temperature is in the installation of a thermostatic control valve, so that when the high side of the variation of temperature is reached (180 deg. high, 170 deg. low) the valve shuts off, and when the low side is reached the thermostatic valve opens and remains open until the high side is reached.

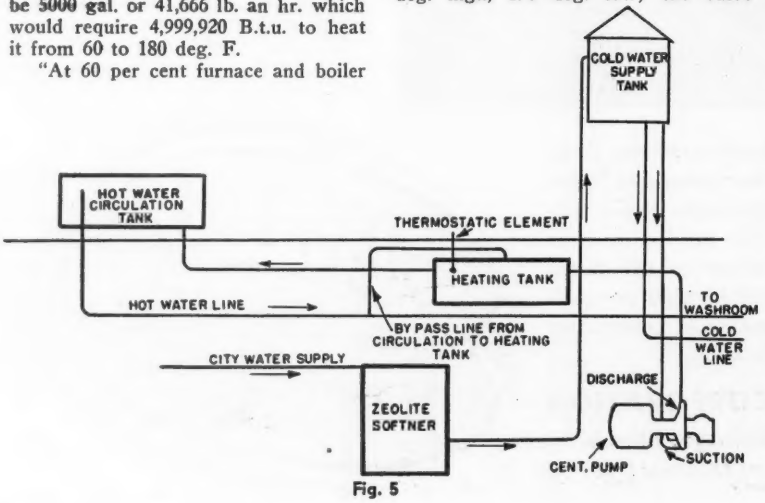

Fig. 5

I believe the two tanks in Mr. Christenson's problem are of sufficient capacity for the storage of his hot and cold water.

Any cold water for the rest of the plant above the first floor is fed by city water. The cold water or storage tank should be from 40 to 60 ft. above the street level; the hot water tanks as in our case are situated from 2 to 8 ft. below the cold water storage tank.

If another is being added to the equipment, then this could be used for the storage as well as part of the hot water circulation system. From the coil heating hot water tank to the (newly added tank) to the pump to the hot water system.

The letter of Cloyd J. Ray of the Quartermaster Laundry at Fort Riley, Kan., deserves comment because of the practical way in which he analyzes the situation. With his background of practical experience in the laundry field his suggestions should bear considerable weight. He writes:

"Regardless of what sort of water heating arrangement Our Hero's friend may decide to install, one thing is quite certain. That is the need for additional water storage.

"I would suggest using the additional tank as an open storage heater, and installing an electrically driven pumping unit to supply the hot water to the washroom. By such an arrangement, he could, after a little experimenting, feed cold water to the heater at a constant rate, allowing the water level to vary during operating hours and eliminate that "typical laundry load. He could, of course, use his present pressure system and install closed storage heaters, but he would still need the storage tank and would still have a fluctuating boiler load.

"The best method of heating water in the new storage tank depends a great deal on the present layout. That is, whether to use closed coils and return the condensate to the boilers or, to heat direct through perforated pipes, using make-up as at present.

"The pump should be connected to the tank at two points, at the bottom and, some distance above the bottom, the proper distance depending on the tank dimensions. The upper opening would be used in normal operation, the lower one when use of entire supply is needed or when it is necessary to empty the tank for repairs or cleaning.

"The chief points in favor of this plan are: simplicity, low first cost, low maintenance cost, no water wasted, and most important, 'smoothing out' the boiler load conditions."

"This outfit will heat water (10,000 gal. of it.) to 200 deg., for 10 min. at 2 lb. steam pressure. With this outfit the 15,000 gal. tank would not be needed at all."

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with **LUNKENHEIMER**

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Fig. 2125

Fig. 2129

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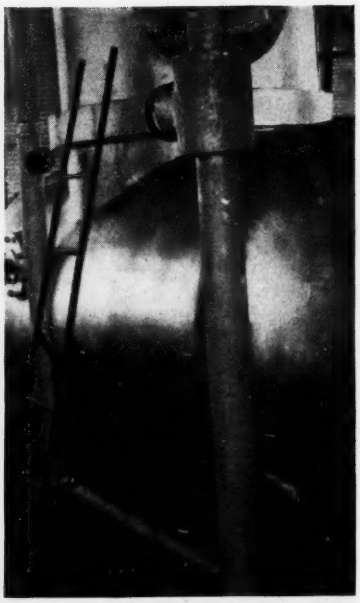
SHOP TALK

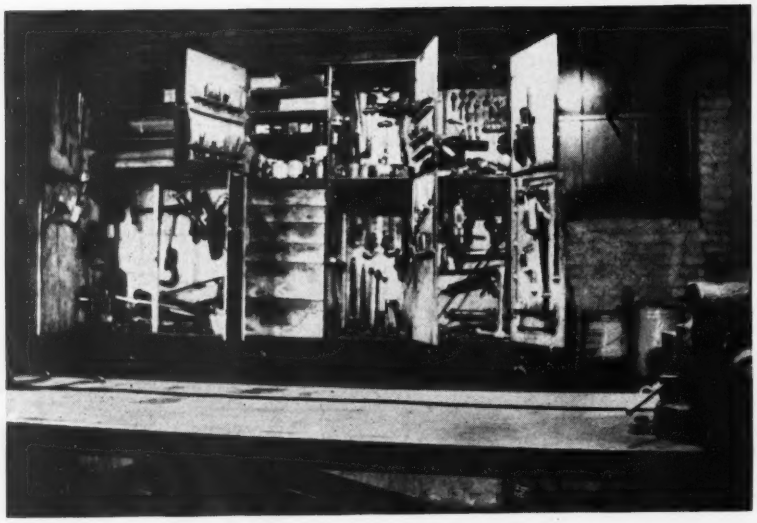
A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

PIPE HANGERS—Leslie Bradley of Bismarck, N. D., has worked out a convenient arrangement for making U bolts for pipe hangers. The accompanying photograph shows an assembly of different sizes of pipes which they use in the plant for bending U bolts for pipe hangers. The length of the rod required for each size pipe is stamped on the top of each section. The base of the assembly is made of 8 in. channel iron and is clamped in a vise when used. The arrangement is simple and it has proved a great time saver. It also helps to prevent wastage of material.



HANDY LADDER—The ladder shown in the above photograph was made of iron pipe to permit easy reading of a thermometer above the feedwater heater at the plant of the Atlantic Gelatin Co., Inc., at Woburn, Mass.

TOOL CABINET—Below is shown the tool cabinet used in Leslie Bradley's plant in Bismarck. This cabinet, made of plywood, provides a centralized and convenient place for all tools used in the plant. It is 10 ft. long, 20 in. deep and 6 ft. high and is made of ¾ in. plywood. Various compartments contain different varieties of tools and racks on the inside of all the doors support groups of small devices. One section is provided with drawers for small loose parts. Recently an addition was built to hold the special wrenches supplied in connection with a new turbo generator installed in the plant.



POWER FILE—Here, at the left, is a gadget that should bring joy to the heart of anyone doing a lot of filing. It is a multipurpose tool made by the H. & H. Research Co. of Detroit, being used for precision filing. Because of the reciprocating motion of the file there is no need for moving the arm, eliminating much of the tendency towards a rocking motion, a natural consequence of arm movement when filing flat surfaces.

The only movement that this action picture caught is the blur of the file in the chuck of the tool, showing that the arms and hands can be held steady while doing the work. These tools are manufactured in two stroke lengths, ⅜ in. and ⅛ in., permitting the operator a selection in adapting the tool to the type of work done.

It is claimed by the manufacturers that even an operator with little training can do accurate work. Such a tool should have many uses in the power plant.

In the photograph a file is shown, but it is possible to use other tools that operate by virtue of a reciprocating motion. The head is light enough in weight so it can easily be held.

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'Round About

with the Engineering Editor

Montaup Station's new 2000 lb. forced circulation boiler has every joint welded . . . 2000 field welds . . . The three circulating pumps, 50 lb. differential, take 125 hp. each, but cut overall efficiency only a fraction of 1 per cent . . . Expected heat rate of the topped station said to be about 11,300 B.t.u.

* * *

National Defense power requirements . . . The Cincinnati electric system over a long term period had a peak increase of about 11,000-kw. a yr. In the late 20's and 30's the rate of increase was 13,000-kw. a yr. . . . An allowance of 20,000-kw. has been made for 1941 and to take care of National Defense emergencies, 40,000-kw. have been provided each year of '42 and '43 . . . The estimated 1941 peak is about 290,000-kw., about 47½ per cent industrial load, about 22 per cent residential.

* * *

Bills for licensing stationary power engineers and boiler operators have been introduced into both houses of Congress . . . HR 1043 in the House . . . S 1128 in the Senate . . . If interested get copies from your congressmen . . . Said to have the backing of the N.A.P.E. . . . Automatic blackout of power stations is here . . . at least one station is being built without windows . . . and with complete air conditioning . . . The new Douglas Aircraft factory at Long Beach, Cal., is also a blackout plant . . . 2400 t. of refrigeration capacity will be required for air conditioning.

* * *

In a city which is one vast archive . . . an imposing building "The National Archives of the U.S." excites curiosity . . . 3,000,000 cu. ft. of the most vital records, some compressed, some microfilmed, are kept . . . treaties, state papers, pension records back through the Revolutionary War . . . Perhaps you thought that pudgy Gen. Putnam rode down that flight of stone steps to outwit the red coats?

He didn't . . . **Joseph Rundel,** *who was running just as fast for the same reason but had a head start and stopped to look back said . . . "he did not ride down more than 15 or 20 (over 100 in all). He then dismounted and led down his horse as quickly as he could" . . . with the British horse on his heels . . . his haste was understandable and his restraint admirable.*

* * *

Andre's capture, his grave and death watch . . . all down by participants in longhand 150 yr. old . . . And shades of St. Michael . . . Benedict Arnold's British regiment originally intended to be made up entirely of American deserters . . . was . . . The American Legion . . . It took a century and a half, a world war and five million young men to make the name truly American.

JUST TO KEEP the record straight . . . We thought wrong in the July issue by about 50 per cent . . . the proposed spreader stoker fired 150,000 lb. unit for the Hubinger Co., Keokuk, is not the largest of that type . . . A 225,000 lb. per hr. Foster Wheeler boiler fired by Detroit Rotostokers has been in service for some weeks at Studebaker's So. Bend, Ind., works . . . "Right now," says boiler room foreman **Tom McQueen,** "we're carrying about a 200,000 lb. load, burning up some mixed tailings from experimental coal piles, but we get a nice ash" . . . with that he reached in and grabbed a handful of ash falling off the tail end of the traveling grate, 18 in. from a 2 in. bed of live coals! . . . **Ray Bucks** is chief engineer . . . **V. C. Uldin,** plant engineer . . . **Otto Klausmeyer** is plant engineer of Studebaker's new Aviation Div. . . . building three new plants,—So. Bend, Ft. Wayne and Chicago—for aero engines . . . **Jack Martin** is his assistant.

John Spier, engineer, Frankfort Distillery, Louisville, has high rents and Old Man River licked . . . he lives in a houseboat, moored just below the bluff on which he was born, and lives high or low depending on the river level . . . **J. D. Williamson,** Results Engineer, Millers Ford Station, Dayton, is now a captain in the army . . . **Vernon Edwards** is now Chief Engineer of the Hobart Mfg. Co., Troy, O. . . . He was formerly with the Marion-Reserve Power Co., Marion, O. . . . This latter company recently completed a 12,500 kw. addition to its Scotia Plant . . . 900 lb. B. & W. boiler, Hagan control, Westinghouse stoker, turbine and condenser . . . **G. M. Ditter** is production manager.

For 150 yr. Europe has been the home of the metric system, yet Professor **A. G. Christie,** Johns Hopkins Univ., is authority for the statement that the Belgian weavers and bricklayers reckon in yards . . . in the markets of Hungary, at least before the war, you bought fruit by the pound weighed out with old English weights . . . not the kilogram . . . Apparently this goes back to the same era as the old Maria Theresa dollars still current in Africa.

From Knoxville, **S. M. Woodward,** TVA water control engineer . . . weekly fluctuations of the pond level a few feet is an effective method of mosquito control . . . The larvae dry out and die and the vegetation among which they breed is killed . . . The TVA also supplements this with Paris green in swampy areas and oil in open spaces.

It is said G.M. has the capacity to produce two mobile Diesel power units a week . . . The R.E.A. makes extensive use of them and just put Nos. 19 and 20 into service . . . **Dr. Davis'** (Stevens Institute) 3-4-5 formula for toastmasters . . . 3 drinks, 4 stories . . . 5 min. . . . **Prof. Straub** (U. of Ill.) says a pH value of above 8.5 should stop feedline corrosion . . . British Notes . . . Britain manages to have 85 per cent of bombed houses habitable in 5 wk. or less . . . the rest are demolished . . . Essential production of non-military needs limited to "nucleus" firms selected by agreement . . . others are closed down but receive share of profits from the nucleus plants . . . Distribution will probably be handled the same way eventually . . . Other production, like textiles allowed because not convertible to military uses, is arbitrarily cut . . . 20 per cent for home consumption . . . 80 per cent for export.

Thermostatic traps and the N. D. H. A. . . . **G. K. Sauerwein** of Harvard reports . . . 1565 traps in service over 15 yr., repaired at average cost of $2.25 per trap . . . **R. Y. Sigworth** of Penn State checks him within a few cents on . . . 185 traps repaired one year and 95 the next year out of a total of 3300.

While rifled barrels were in common use in Pennsylvania and Virginia in Revolutionary times, they were a novelty in New England . . . the battle of Bunker Hill was fought with smoothbores . . . when they had the lead the Americans loaded with one solid ball and seven buckshot . . . an obvious advantage for the boys with faulty aim . . . the British Army muskets, with no rear sight, were fired from the hip in formation . . . "Vas you dere, Charlie?" No . . . all this from Mason's Three Harbors (Charleston, Boston & the Bahamas) a fine tale of strife and uncertainty in Colonial America.

Phil Sprague of the Hays Corp., who gets a lot out of life besides business, has built a cloth house . . . 33 ft. square, 9 ft. ceiling covered with special cloth from Connecticut developed for the tobacco growers . . . Flowers thrive and it makes a perfect insect proof summer house . . . If you want to make a grand gesture and show the wife how clever an engineer you can be, build one . . . a guaranteed cure for the wanderlust and the need of a long vacation away from home.

Richard H. Morris

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Fluorescent Lamp Factory Starts Production

WITH the completion of initial construction work on its fluorescent lamp factory, the Westinghouse Electric & Mfg. Co. on August 1 started production of this new type of lamp on such a large scale as to put this part of the industry well along in volume of production. This factory was started this year and, in less than 5 mo. the $3,000,000 windowless zone air conditioned manufacturing plant with nearly 5 acres of floor space under one roof is now in production near Fairmont, W. Va. It will have an ultimate capacity of 200,000 lamps a day, requiring 40,000,000 cu. ft. of fuel gas per month, the supply of which was one of the determining factors in the selection of this location. Some of the other factors were transportation facilities, electric power, water service and an adequate supply of specialized labor.

Starting from scratch in March this year, the Westinghouse Electric & Mfg. Co. has constructed and put into production an entire factory for making fluorescent lamps. This plant is located near Fairmont, West Va., and is designed along "blackout" architectural lines. It is one story high, with no windows, complete air conditioning and with provisions for protection against sabotage and bombing. The cost was $3,000,000 and the full capacity will be 200,000 lamps a day. These features are described briefly with some details of the air conditioning, electrical circuits and lighting provisions

Designed for Blackout

Without windows from which lights could be seen at night the single-story main plant is inconspicuous at night even when full production is under way. This structure is 224 ft. wide by 885 ft. long, houses all fluorescent-lamp-manufacturing machines, a 6-wk. supply of raw materials and finished lamps, general offices, locker and toilet rooms, first aid station, recreation rooms, cafeteria, kitchen, and a machine shop. The entire building is constructed of permanent, non-combustible materials. The framework is of structural steel, with interior steel columns and exterior masonry walls, topped by stone copings. The roof consists of a poured gypsum deck with built up tar and gravel roofing on top.

Air Conditioning

Working conditions in this plant must be closely controlled which was the principal reason for the windowless design of the plant. Dust-free air is particularly important in the manufacture of fluorescent lamps; dust particles clinging to the inside of the glass tubes before coating produce irregularities that may affect operation of the finished lamp. For this reason the regular air-conditioning system is supplemented by Westinghouse Precipitron electrostatic air cleaning cells which remove approximately 90 per cent of all air-borne particles before incoming air is circulated in the plant. Air in all ducts is irradiated by a total of 600 Sterilamps which destroy bacteria and other micro-organisms. Shipping and receiving rooms are provided with air curtains (separated double doors with air chambers between), to help keep dust out of the plant. The air conditioning system is provided with zone control to keep temperature fairly uniform throughout the plant, despite widely varying processing conditions, and secondarily to make sabotage or bombardment less effective. Air is not recirculated in the main manufacturing area but in the offices the proportion of fresh air to recirculated air can be adjusted to suit requirements. When heat is needed in the building it is supplied by gas-fired unit heaters.

Air cooling is accomplished by two separate systems of circulating water. The primary system consists of a 3600 g.p.m. flow of water at 55 deg. F. pumped from an abandoned and sealed coal mine 1800 ft. away and 150 ft. lower in elevation. Mine water is pumped to a heat-exchanging reservoir just outside the building, thence back to the coal mine through a drill hole. The secondary system consists of a closed circulation of ordinary city water, through cooling coils in the building, thence to the heat-exchanging reservoir, where heat is extracted and carried away in the primary system. Heat exchange is accom-

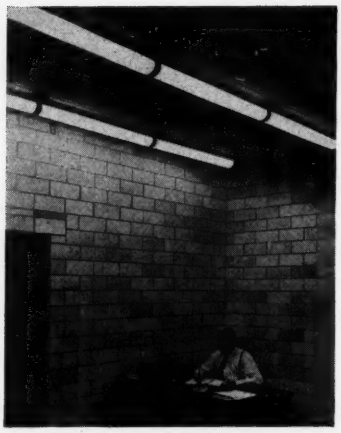

Fig. 2. Fluorescent strip lighting fixtures provide about 50 foot-candles at the desk in this typical office and the anemostat at the top of the picture provides atmospheric comfort

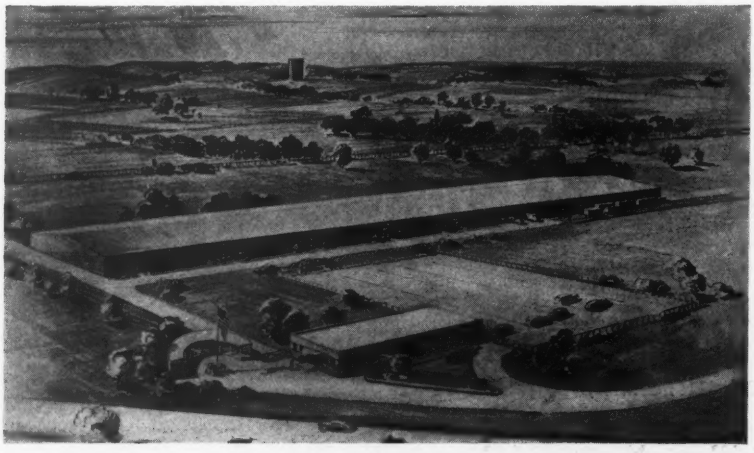

Fig. 1. Architect's conception of the blackout fluorescent lamp factory recently built by Westinghouse

Why everyone with a hand in plant piping prefers

TUBE-TURN *Welding Fittings*

Naturally, you are *most* interested in the particular ways that Tube-Turns help *your* department and *your* problems. You'll find them in the above illustration.

But go further. Note the equally strong advantages that Tube-Turn welding fittings offer to *all* departments in your plant that are concerned with piping.

By viewing here *all sides* of the Tube-Turn story, you see *why* Tube-Turns have earned ever-increasing preference—constantly wider applications—and the leadership held since their *origination* of the welding fitting idea.

There's a Tube-Turn for *every* welding fitting need, in all types, sizes and weights. Write for helpful catalog and data book. TUBE-TURNS, Inc., Louisville, Ky. Branch offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Los Angeles. Distributors everywhere.

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Welding Fittings

plished by copper coils completely submerged in the mine water.

Electrical System

Because it provides the high degree of reliability necessary for a glass-working plant, the low-voltage secondary network system of distribution is used; it is well adapted to subsequent plant expansion; and is economical, since only one system is necessary for both power and 120 v. lighting circuits.

Reliability of the network is increased by feeding it from two different 66-kv. incoming lines through two 3000 kv-a. CSP (completely self-protecting) transformers of the unit substation type, and by using duplicate feeders. Distribution voltage to the six 3-phase 500 kv-a. air-cooled network transformers is 6600. Normally three transformers are connected to each feeder. If a network cable fails, half the transformers will carry the plant load until the others can be switched over. If a transformer should fail, network protectors and current limiters would isolate it and the remaining transformers would carry the whole load; consequently, any section of the network, or even an entire circuit, may be disconnected without causing a shutdown.

If the plant is enlarged, or if production lines need to be rearranged, the network can be easily extended or changed to fit the new load distribution. The system is laid out so that taps from the secondary loop will be as short as possible. The cross-connecting link of the network is located where a large concentration of load requires a heavy feeder, so at small extra expense the load is served better by feeding it from two directions and the network copper is worked to better advantage.

Load taps are not connected directly to the secondary loop, but to a bus duct through current limiters. Wherever a transformer connects to the network, four cables are tapped off and run to De-ion air circuit breakers, then to bus ducts and branch circuits. Breakers are used singly or in groups on convertible power panels. Line-to-line voltage, used for power and processing loads, is 208 on the 4-wire 3-phase system; lighting units are connected from line to neutral.

Illumination Intensity 40 Foot-Candles

All light in the plant, except the cafeteria, is supplied by a total of

Fig. 3. Lighting panelboard, typical of those throughout factory

5100 40-watt fluorescent lamps. Total lighting load is 255 kv-a. for the entire building, which is equivalent to about 1.3 watts per sq. ft.

Manufacturing sections are lighted at an intensity of 40 foot-candles, which is twice as great as the average for similar plants. Westinghouse RIM twin-lamp open-end luminaires are hung end to end to form continuous light troughs spaced 12 ft. 3 in. apart at heights varying from 10 to 13 ft., depending upon requirements of individual departments.

Special vapor-proof units with gasketed glass covers are used in

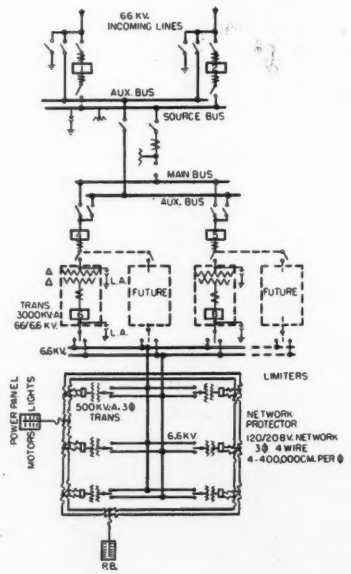

Fig. 4. Electrical network system employed in blackout plant

the coating and drying, ball mill, and solvent departments to protect the lamps and reflectors from process gases. All fixtures have twin ballast units, providing a power factor of from 95 to 99 per cent.

Offices, corridors, and other service areas are lighted by commercial single-lamp units of the surface-mounting type. In offices the units are mounted end to end on 3 to 4 ft. centers at a ceiling height of 10 ft.; units in the cafeteria are mounted end to end and spaced in six rectangular groups. In other areas mounting heights vary from 9 to 12 ft.

Emergency units are supplied continuously from an automatic change-over switch to which two sources of 120 v. single-phase 60 cycle power are connected. One source is a regular network panelboard; the other is a 50 kv-a. emergency engine-driven generator set.

Yard lighting and protective floodlighting are provided by thirty-six 1000-watt and seven 500-watt floodlights mounted on 25 and 34 ft. poles. Three other units are mounted on each end of the roof of the main plant. All yard and floodlighting units are operated from a "blackout control" pushbutton in the police office.

Auxiliary Buildings and Services

An industrial relations building is located at the main entrance to the plant, near the bus terminal and parking lot. In it are housed the police headquarters, purchasing department and a two-car garage. Since most visitors will be either salesmen or applicants for employment, these departments were located here for convenience to visitors and to minimized interference with operations in the lamp plant.

The building is similar in construction to the lamp plant, except that it has windows throughout, and steel joists carry the roof deck. It is arranged so that all employes and visitors to the plant must go through the building before gaining access to fenced-in areas.

The medical department was planned and equipped in accordance with best practice in modern hospital design. The equipment includes a latest type of X-ray machine, which will be used for examination of all applicants for employment as well as for periodic check-ups of employes.

MAKE THIS 3 TO 5 TEST YOURSELF

There's less chance for faulty alignment in this "Tri-Fit" Design. The greater precision of only three section-fits cuts wear, cuts vibration, cuts trouble!

See how old-style motor pumps have five or more section fits, greater danger of faulty alignment, trouble-making vibration, more wear, less power!

And See How Allis-Chalmers "One Package" Pump Unit Eliminates Two Trouble-Making Fits and Saves You Up To 33%!

FEWER PARTS mean fewer headaches! That's one big reason the Allis-Chalmers "Electrifugal" Pump meets ...and beats every pumping challenge.

But we want you to be the judge. Check its new "Tri-Fit" construction yourself . . . and see why there's more positive alignment of the single shaft, less wear and tear . . . and smoother running, vibration-free operation.

Into this improved design has gone all the genius of Allis-Chalmers engineering experience. A new motor . . . 100% designed for pump drive . . . and *completely splash-proof* . . . gives greater mechanical strength.

One piece frame saves as much as 33% in space . . . 40% in overhang! Indestructible rotor and distortionless stator provide low maintenance and trouble-free service. Cast bronze protective sleeves, splash-proof ventilation and cast aluminum fans are other features that make this compact pump the choice of every industry.

Best of all . . . *you can actually cut your initial costs as much as 33% over conventional pump installations.*

For the money-saving details on this new "One Package" Pump . . . call the engineer in the district office near you. Or write Allis-Chalmers, Milwaukee, Wisconsin, for Bulletin B-6140.

A 1434

✓Check These Great One-Package Features:

1. *Up to 33% Space Saved* with one frame, one solid driving shaft construction.
2. *Overhang Cut As Much As 40%.* Four solid supports assure precision balance . . . ease strain on vital parts.
3. *New Tri-Fit Design* eliminates 2 section fits for more positive shaft alignment, wear-less and vibration-free performance.
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IMPROVED DAMPER Aids Paper Mill

By stopping leakage past by-pass damper, paper mill boiler plant added 100 hp. to capacity

BY GEORGE URBAN
Marathon Paper Mills Co.

INCREASING steam demands led to a study of boiler room conditions in the power plant of the Marathon Paper Mills Co. of Rothschild, Wisconsin. This study indicated that capacity and efficiency could be gained if certain damper leakages could be eliminated.

There are four 390-hp. four drum bent tube boilers and one 870-hp. straight tube cross drum boiler in the plant. Steam is generated at 150 p.s.i. without superheat in the small boilers and with 125 deg. F. superheat in the large boilers. Northern Illinois and Eastern coal is fed from an overhead bunker to spreader type stokers. Ashes are removed to a storage tank by vacuum. The large boiler has its own economizer, induced draft fan and stack. Its output is controlled by means of a damper in the outlet of the induced draft fan.

All boilers are under the control of a metering type combustion control system. A master regulator imposes a loading on each boiler regulator which adjusts the uptake damper. Furnace draft is maintained constant by a separate regulator that adjusts the damper at the forced draft fan. Fuel feed is controlled by a third regulator in response to loading by the master regulator. Very satisfactory operation is maintained although the load fluctuates quickly over a considerable range. Six wood refuse burning boilers generate a variable quantity of steam and aggravate the swings on the main plant.

The four smaller boilers are set in two batteries of two each. The gases from each battery pass through an economizer and induced draft fan and are discharged to a common flue leading to a second stack. A natural draft bypass around the economizer and induced draft fan connects the breechings in back of each battery to the common flue. These bypasses are used once each week during inspection and cleaning of the economizers. They are equipped with dampers to prevent gas flow through them when the fans are operating and the desired flow is through the economizers.

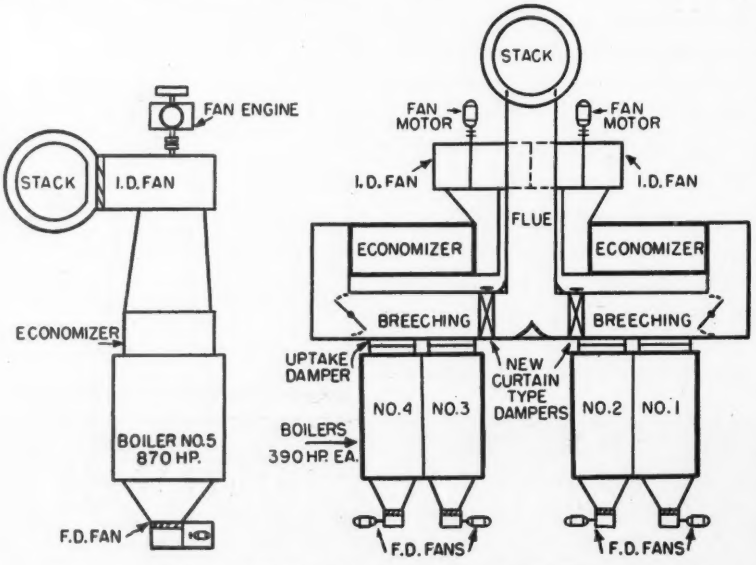

Fig. 1. Boiler layout indicating damper locations

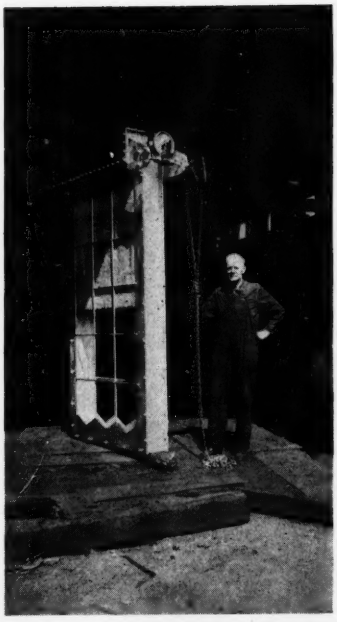

Fig. 2. Curtain damper before installation

Considerable leakage was found to be occurring through these dampers. Thus when the draft in the flue exceeded the draft in the breechings hot gas would tend to short circuit the economizers and loss of efficiency followed. When the draft in the breechings exceeded the draft in the flue, chilled gas was drawn from the flue into the breechings. This cool gas reduced the temperature and increased the volume of the gases entering the economizers, resulting in lowered heat absorption, increased draft loss, excess load on the induced draft fan and reduction of draft in the flue. These conditions lowered efficiency and capacity. It was decided to replace the existing dampers with curtain type dampers which would prevent the undesirable leakage.

One of these curtain dampers has been installed and a second one will be installed as soon as load conditions permit. Due to the fact that a variable quantity of feedwater is drawn from the economizers for the six wood refuse burning boilers, it is difficult to determine exactly what gain in efficiency has been realized. However, approximately 100-hp. additional capacity and 50 deg. F. increase in temperature of the gases entering the economizer has been observed. These observations indicate that the installation is well justified and that substantial gains have been accomplished by a very moderate expenditure.

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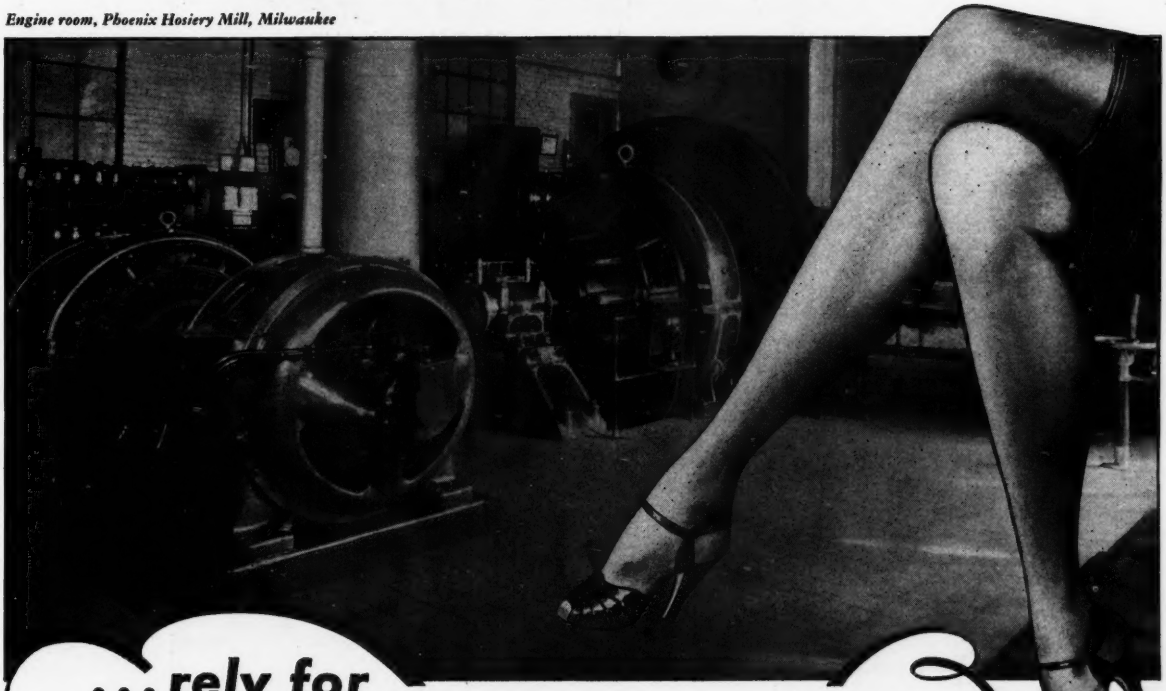
Engine room, Phoenix Hosiery Mill, Milwaukee



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New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

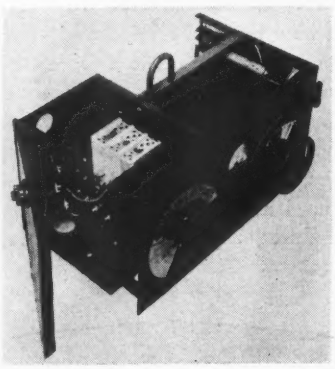
Industrial Multi-Breaker

A NEW breaker, for application as a motor circuit, switch or service disconnect switch, has been recently announced by Cutler-Hammer, Inc., Milwaukee, Wis. It is fuseless, with bi-metallic strip actuation, visible trip indication,

and trip free lever. Also being quick make and quick break, with a rated capacity of 230 v. from 15 to 100 amp., available in 3-pole, 3-pole solid neutral, or 4-pole solid neutral types. Calibration is set at the factory. The breaker is completely enclosed and semi-dust-tight, with front access and operation.

Arc Welder Control Box

FURTHER improvement in dual continuous control for arc welding machines, in the form of a new welder control box of advanced design and construction, is announced by The Lincoln Electric Co.,



Cleveland, Ohio. The new box, designated "Type G", prevents accidental contact with live parts, increases accessibility, permits wiring with flexible or rigid conduit, or rubber-covered multiple-conductor cable and eliminates dangers from unintentional loosening of the lifting hook.

There is a separate compartment for all a.c. circuits, including push button, and another separate one for d.c. terminals. Both a.c. and d.c. compartments have a snap catch which holds the door in closed position. On the d.c. compartment, the snap catch feature of the door makes the terminals readily accessible without the use of tools and, at the same time, provides a complete cover for the terminals when the door is closed.

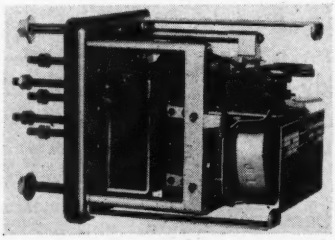
Special non-shortening lugs, which lock themselves in proper position before they can be bolted to the input terminals of the starter, prevent the possibility of blowing up the input lines due to shorted input lugs because of careless maintenance.

The control box is permanently grounded to the motor and generator frames through the mounting bolts to take care of special inspection rules which require that both the control box and the frame should be grounded. This feature makes it possible to ground both the control box and the machine by simply grounding the conduit which leads to the box.

An additional feature is a new lead clamp which prevents the bending or damage to output studs when the welder leads are accidentally jerked or pulled.

Relay to Interrupt 100 Amperes

GENERAL ELECTRIC CO. announces an improved a.c. tripping form of IAC relay, rated to interrupt 100 amp. around a trip coil. The new design employs thick-contact brush and massive contacts,



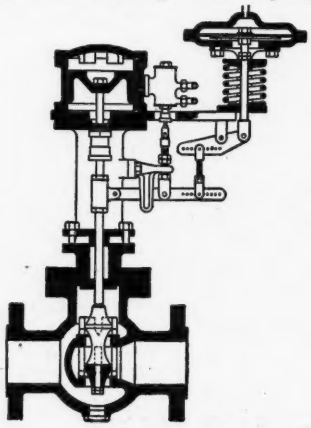
which retain the heat thrown off by the arc, and permit a rating of 100 amp. for 2 sec.

Trip coils with resistances up to four ohms can be safely handled with the new relay, though the contact pressure is weakened when carrying current too long.

Koldboard is a new insulating block with mineral base, for low temperature work, stated to be moisture repellent by the manufacturers, Baldwin-Hill Co., Trenton, N. J. Standard blocks are 36 in. long, 12, 18 and 24 in. wide, ½ to 2 in. thick. Cuts cleanly to fit irregular spaces.

Improved Pressure Reducing Valve

NORTHERN Equipment Co., Erie, Pa., announced recently an improved design of the Copes Type R-DSLH pressure reducing valve, a relay operated unit used for remote control from a master controller. The principal changes have been in the mounting of the diaphragm



operator receiving pressure impulses from the master, and in the linkage by which the diaphragm movement is transmitted to the relay-operator of the valve. These parts have been strengthened and arranged more compactly to assure more rugged installation and more accurate installation. The valve can now be furnished in sizes from 1- to 14-in., and in all pressure standards from 125 to 1500 lb.

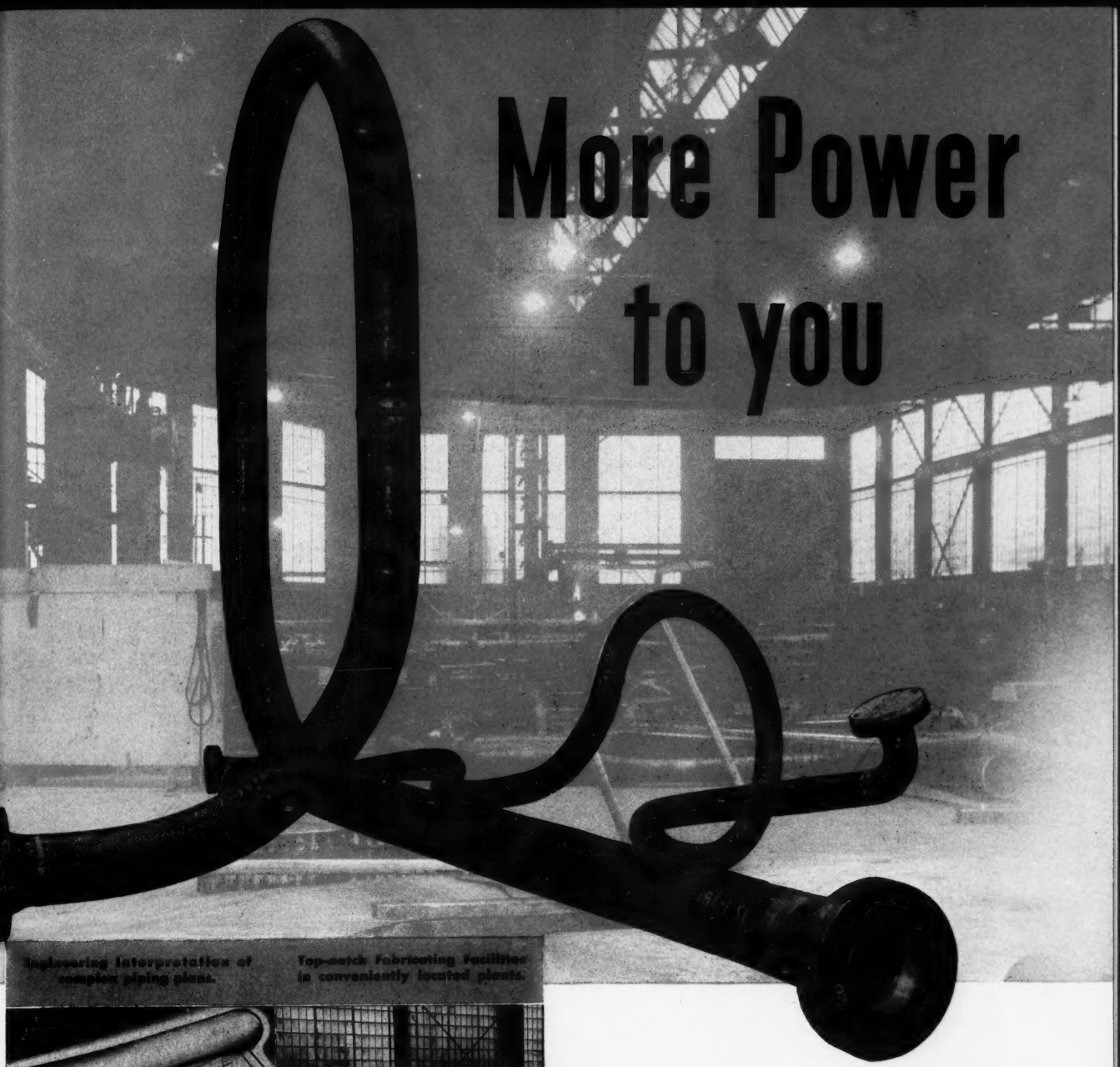
Unit Substations

METAL-ENCLOSED, factory-built unit substations, compactly designed for power and lighting service, are announced by the General Electric Co. These consist of one or more metal-clad switchgear units in the incoming-line section, a 3-phase transformer section filled with oil or Pyranol, and one to 15 metal-enclosed air circuit breakers on the low-voltage-feeder side. They can be installed indoors or outdoors to transform power from the 2300 to 15,000 v. range to 600 v. or below and to provide protection and control for the low-voltage feeders.

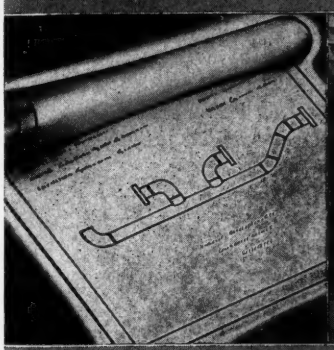
Use of Pyranol in transformers permits installation indoors without fireproof vaults at load-center locations, eliminating long, heavy, low-voltage feeders.

All wiring, control, and metering equipment is mounted on hinged panels for easy accessibility, while drawout relays simplify inspection. Access to the bus, current transformers, and feeder connections for each breaker can be gained by unbolting and removing the back plates; mechanical interlocks prevent connecting or disconnecting of the breaker while it is closed.

More Power to you



Engineering interpretation of complex piping plans.



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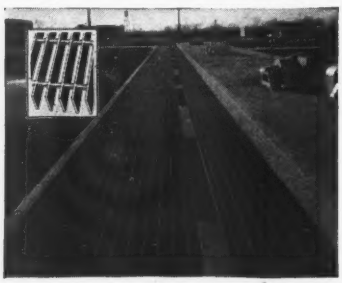
Impact Wrench

A Tool weighing only 4 lb., which is reversible and can handle up to and including ⅜ in. bolt size has been announced recently by Ingersoll-Rand Co.

Phillipsburg, N. J. Form-fitting pistol grip handle, short over-all length and small nose diameter permit operation in close places. This and other sizes handling up to 1¾-in. nuts are included.

Steel Grating

Welded steel grating of one-piece construction, with non-slip surface and self-cleaning has been recently announced by W. F. Klemp Co., Chicago, Ill. Hot-rolled hexagonal steel bars are placed at



right angles in notches on top of flat bearing bars which are set on edge and electro-welded to give smooth joints. Standard grating is of bars set 1 3/16 in. centers in panels 24 in. wide and lengths up to 35 ft. Panels of odd dimensions can be furnished as needed.

Glareless Permocharts

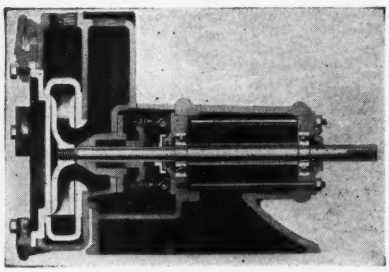
Production of the new I-EZ (eye-ease) Permochart, a recently improved design of recording instrument chart made for continuous re-use, has been announced by the Permochart Company, 510 Chestnut Road, Sewickley, Pa. The new I-EZ Permochart is made in three colors of Vinylite plastic, so colored and shaded as to reduce glare and eyestrain to a minimum.

The three color of I-EZ charts, green, ivory and blue, can be used to advantage in identifying different units or operations, making inspection of charts easier.

Like the white Permochart, colored I-EZ charts are made for all types of recording instruments using circular charts. Permocharts are non-flammable, oil, gasoline and grease resistant, and entirely waterproof. No meter changes are required, as these charts are affixed and removed in the same manner as paper charts. Same pens are used, and any of the regular recording inks provide satisfactory contrast for good record visibility when used with any color I-EZ chart. At the end of each 24 hr. operation, the ink record is easily removed from the chart surface with a damp cloth, and the chart is ready for re-use.

Horizontal Shaft Pump

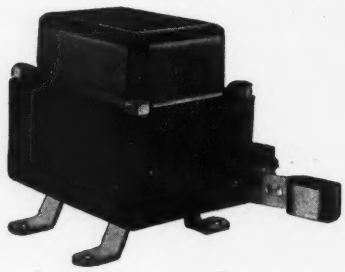
The Amsco-Nagle pumps in sizes from ¾ to 6 in. and capacities up to 1400 g.p.m. at heads up to 100 ft. have been recently announced by the American Manganese Steel Division of American Brake Shoe & Foundry Co., Chicago



Heights, Ill. They are fitted according to requirements to resist corrosion and abrasion, with clamp-bolt construction of the water end, sealed bearings, accessible stuffing box and self priming. Two, 4 and 6-vane shrouded propellers and 4-vane open type are available.

Float Switch

Square D Co., Detroit, Mich, announced recently a new type explosion-resisting and water-tight float switch type 9048AW water-tight illustrated. Enclosure is a heavy cast-iron cover and base, with a rubber gasket to make it



water-tight. The explosion-resisting switch has surfaces between the cast-iron cover and base carefully machined. Entries to the switch chamber are through approved openings by closely-fitted steel shafts. 110 to 550 v. a.c. or d.c.

Junior model of Schaub Trapless System for condensation recovery and boiler feed in laundries and processing industries with boilers of 1 to 10-hp. has been announced by Fred H. Schaub Engineering Co., Chicago, Ill.

Conveyor Belt Vulcanizer

For maintenance of conveyor belting in the field, the B. F. Goodrich Co., Akron, Ohio, has developed the Type RO patch vulcanizer which has been added to its line of vulcanizers. This tool is

designed for repairing the covers of conveyor belting, the vulcanizer is round in shape, 10 in. in diameter, of the single heated platon type. It clamps against a steel plate 12 in. in diameter held against the opposite sides of the belt.

Inkless Slow-Speed Recorder

Low-Chart-Speed recorder which requires only 30 in. of chart for a 30-day load and voltage record is announced by the Meter Division of General Electric Co. The speed is 1 in. per day, made possible by an inkless recording mechanism which presses the chart against a typewriter ribbon. Freezing and evaporation are thus eliminated. Many plants use this new system in connection with the regular 60 ft. strip recorder, the short records being filed compactly and any unusual conditions examined more in detail on the longer chart.

Testing machine for routine production control, of 20,000 and 60,000 lb. capacity is announced by Baldwin Southwark Division of Baldwin Locomotive Works. The smaller machine is designed for testing plastics; the larger for metals. Gripping heads are adjustable, with straining yoke operated by a ram at the top. Indicating unit has 2 or 3 dial ranges, interchangeable without interrupting a test, autographic recorder for permanent record of tests. Speed is 15 tests an hour with a single operator.

Where sparks from static electricity offer a hazard, as in explosive and chemical plants, a rubber flooring has been announced by Goodyear Tire and Rubber Co., Akron, Ohio, in four thicknesses, in smooth finish, cleanable by steam or warm water and ammonia. Where desired, solid or pneumatic tires for trucks and wheelbarrows are available, of a static-conducting compound.

New Whitex tracing cloth for making blue prints from pencil tracings has been recently announced by Frederick Post Co., Chicago, Ill. It is stated that good positive prints will also result from pencil tracings, that colored pencils can be used, and that art gum erasures do not show on the prints.

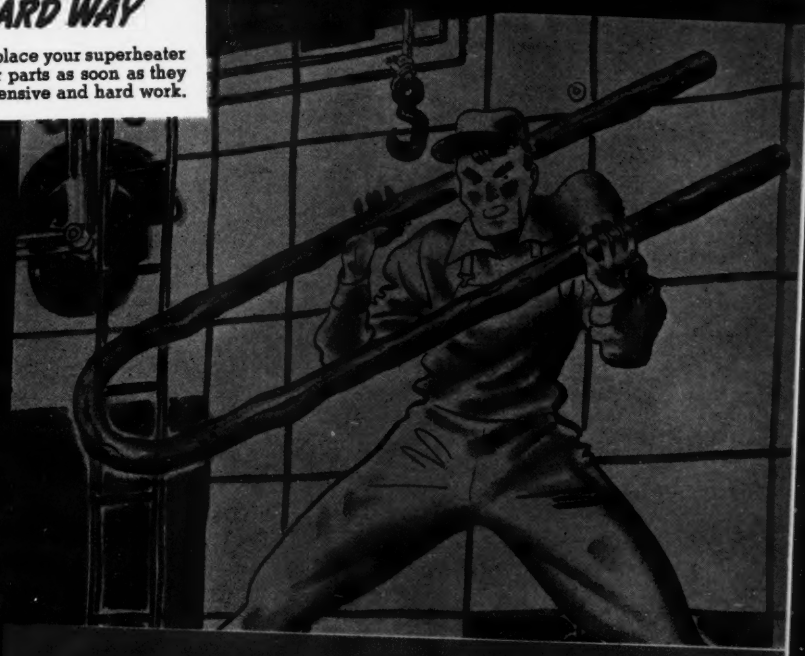
New series of rotary pumps in capacities 50 to 700 g.p.m. for 150 p.s.i. with drive by reduction gear, gearhead motor or V belt, using swinging vane bucket design have been recently announced by Blackmer Pump Co., Grand Rapids, Mich.

Double end hexagon box wrenches in sizes ⅜ to 13/16 in. with heads at 15 deg. angles have been recently announced as No. 36 Set by Bonney Forge & Tool Works, Allentown, Pa.

Two Ways to Control STEAM CONTAMINATION

1 THE HARD WAY

One way is to replace your superheater tubes and other boiler parts as soon as they fail . . . but this is expensive and hard work.



2 THE DEARBORN WAY

A better way is to use Dearborn Treatment and Engineering Service which provides full protection.

When steam becomes contaminated with water and suspended matter, superheater tubes, valves, turbine blades, and other equipment will quickly become eroded and encrusted. You can prevent these troubles by using Dearborn service.

Dearborn Treatment is balanced to provide protection against scale and corrosion, as well as water carryover. It not only prevents new scale from forming but will gradually disintegrate scale already present, while the boiler remains in service.

Dearborn Water Treatment and Engineering Service is designed to fit your individual operating conditions. Dearborn engineers will survey your plant, furnish correct treatment, supply adequate engineering service, and make frequent check-ups to insure best results.

DEARBORN CHEMICAL COMPANY
Dept. F, 310 S. Michigan Avenue, Chicago, Ill.

DEARBORN TREATMENT PREVENTS SCALE AND CORROSION, TOO

Dearborn
TRADE MARK REGISTERED

WATER TREATMENT and Engineering Service

Manufacturers' Personals

Wm. A. Milby of Milby-McKinney, Baltimore, announces the addition of C. C. Brownley to the sales staff. Mr. Brownley is a graduate of John Hopkins School of Engineering and will be actively engaged in sales engineering work involving Cochrane water conditioning equipment, Armstrong traps, Goulds pumps, Ruggles-Klingeman valves, Wagener steam pumps, and D. E. Whiton turbines.

M. J. Tennes, Jr., President, Shafer Bearing Corp. has entered active service as Captain in the United States Army Air Corps with permanent station at the Air Corps Advanced Flying School, Phoenix, Ariz. During the absence of Captain Tennes, management of the Shafer Bearing Corp. will be under the direction of John F. Ditzell, Vice President and General Manager.

A. H. Knipe has been appointed Cincinnati District Sales Manager, 1331 Inquirer Building, for Water Treatment Co. of America.

Edmund D. Walker, formerly Manager of the Fedders Mfg. Co.'s Air Conditioning Division, is now Assistant General Manager of the Company.

Appointment of W. M. Ballenger to the position of Assistant District Engineer of the General Electric Co.'s Central District has been announced by W. O. Batchelder, commercial vice-president. Mr. Ballenger has been connected with General Electric since 1923 when he started on Test, being assigned to the industrial control engineering department at Schnectady a year later, then to the industrial engineering department, and in 1928 to the St. Louis office, where he remained until his transfer to Chicago in 1930.

Election of Larry E. Gubb, former executive vice president, to the office of chairman of the board of Philco Corp., was announced on August 21. Other promotions made public at the same time were: John Ballantyne, former treasurer, elected vice president in charge of operations; Thomas A. Kennally, formerly general sales manager, named vice president in charge of sales; W. R. Wilson, controller, succeeded Mr. Ballantyne as treasurer; and James H. Carmine, former assistant general sales manager, became general sales manager. James T. Buckley, who has been president of Philco since 1939, will continue in that office.

Increased demands for metering and control equipment to operate steam power and process plants has necessitated an enlargement of Bailey Meter Co.'s field engineering staff, by assignment to field duty of L. L. Melick to New York, J. F. Triolo to Philadelphia, G. M. Wallace to San Francisco, B. F. Elias to Cincinnati, D. E. Smith to Buffalo.

The Hele-Shaw Pump Division of the American Engineering Co., Philadelphia, announces the appointment of R. S. Ernst to represent them in Indiana, Wisconsin, and part of Illinois. Mr. Ernst is located at 844 Rush street, Chicago.

D. F. Bennett has been appointed Manager of Radiation and Unit Heater Division of Warren Webster & Co., Camden, N. J.

George B. Ewing, Jr., has joined the staff of sales engineers attached to the Houston office of The Foxboro Co. Mr. Ewing is a graduate of the University of Arkansas and the engineering course at the University of Alabama, with industrial experience in machine and tool-making industries and in petroleum refining operations.

F. D. Hoitt, formerly Chief Engineer, Northfield Seminary, Northfield, Mass., has been appointed Chief Engineer, Nantucket Gas & Electric Company, Nantucket, Mass.

C. G. Skidmore Transferred

TRANSFER of C. G. Skidmore, specialist on motor control for power plants, from New York to Philadelphia is announced by Cutler-Hammer, Inc. Previous to his association with Cutler-Hammer, Mr. Skidmore was employed by the U. S. Bureau of Reclamation as a design engineer on control for power plant equipment.

Allis-Chalmers' Personnel Changes

O. K. MARTI has been appointed consulting engineer of Allis-Chalmers Rectifier Division and his time will be devoted exclusively to research and development work. Mr. Marti was born in Switzerland where he received his schooling and was graduated from the Government Technical University at Zurich in 1916 with Master's Degrees in electrical and mechanical engineering. He came to the United States in 1920 where he became Research Assistant and member of the electrical engineering faculty at Cornell University, Ithaca, New York, and later was made research engineer and then chief engineer of the American Brown Boveri Electric Corp. of Camden, New Jersey. When that company was taken over by the Allis-Chalmers Company in 1931, Mr. Marti joined the latter organization.

H. Winograd, who studied under Mr. Marti at Cornell University and joined him upon graduation at American Brown Boveri Corp. and came to Allis-Chalmers with him in 1931, is appointed Engineer in charge of Rectifier Design, in which capacity he will continue with his present work as well as taking on the duties which Mr. Marti is relinquishing.

F. W. Bush has been appointed Assistant to Manager and J. F. Sellers has been appointed Engineer-in-Charge, D. C. Design. G. W. Clothier will be in charge of transformer sales and R. Bell in charge of feeder voltage regulator sales.

F. G. Gardner Promoted

F. G. GARDNER has been selected to fill the position of acting chief engineer of the Kellogg Switchboard and Supply Co., Chicago, Ill., according to announcement by M. K. McGrath, President. This appointment places a veteran of 40 yr. experience in the electrical communications industry at the head of the engineering department and research laboratory of the company. George R. Eaton, Vice President in charge of Engineering, is taking a leave of absence at the advice of his physician because of ill health. As a member of the Kellogg staff, Mr. Gardner has been engaged in special transmission engineering work, and his background before coming to Kellogg included extensive experience in both the telephone and telegraph communication fields.

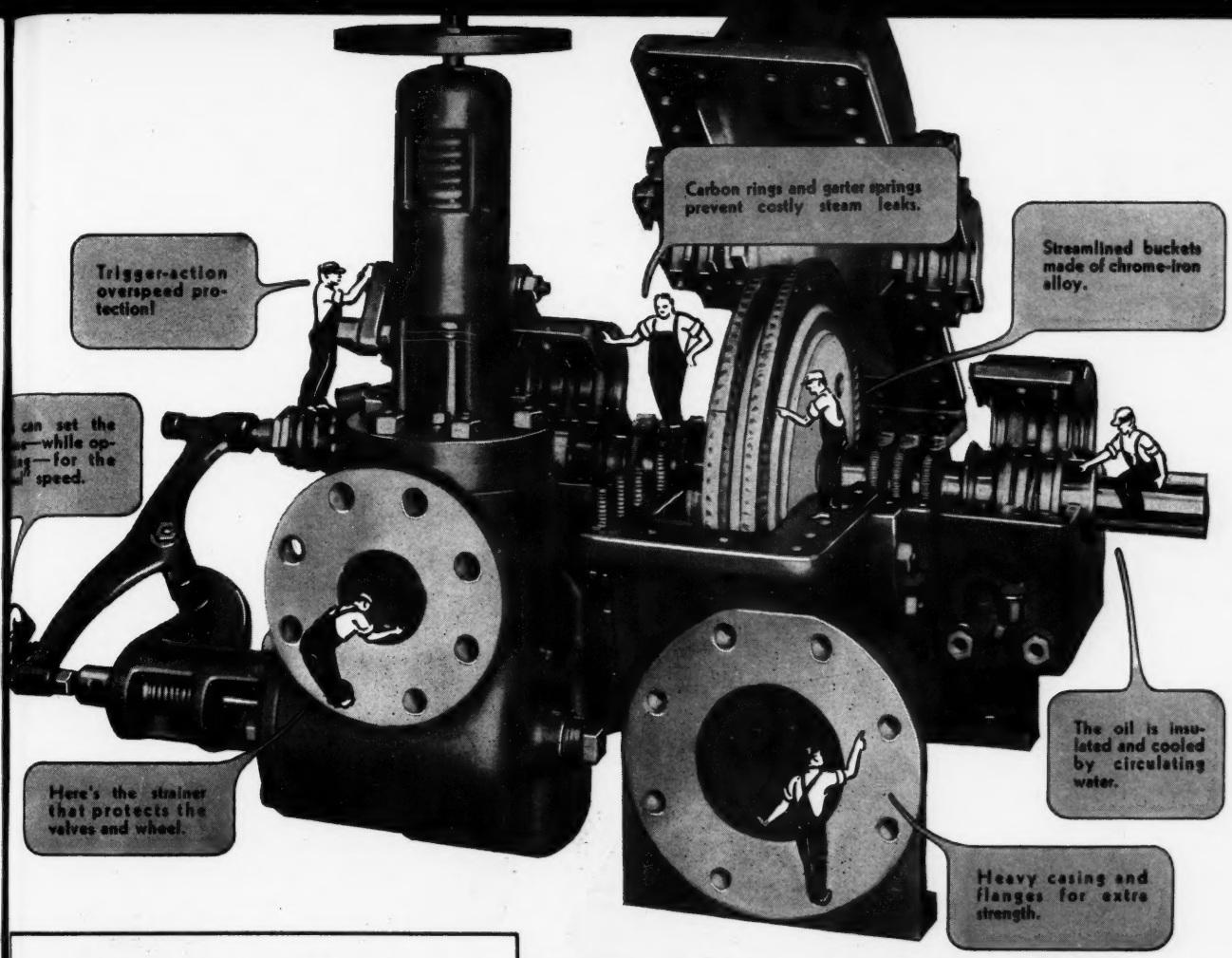
N. M. Barnett, Manager of Bailey Meter Branch Office

BAILEY Meter Company, Cleveland, Ohio, announces the opening of a formal Detroit Branch Office, in place of representation by resident engineers, due to increased demand for sales and engineering service. Located in Room 226 Curtis Building, the office is under the management of N. M. Barnett, assisted by R. F. Hanson and R. T. Cowan.

Elliott Co. Elects New President

HOWARD M. HUBBARD becomes President of Elliott Co. on September 1, 1941, according to an announcement by the Board of Directors. This change in leadership was made necessary by the resignation of James E. Watson from the office of President and member of the Board of Directors, which took effect on July 31, 1941. L. M. Forncrook, Vice President, has been acting as operating head during the interim.

Mr. Hubbard comes to Elliott Co. from the Greenfield Tap and Die Corporation, of Greenfield, Mass., where he has been President and General Manager. Previous to his association with that Company, Mr. Hubbard served in various executive capacities with the Harris-


Carbon rings and garter springs prevent costly steam leaks.
Trigger-action overspeed protection!
Streamlined buckets made of chrome-iron alloy.
can set the —while op- —for the speed.
Here's the strainer that protects the valves and wheel.
The oil is insulated and cooled by circulating water.
Heavy casing and flanges for extra strength.

WHETHER IT'S A 40- OR 160-HOUR WEEK, IT PAYS TO USE TURBINES WHERE . . .

- ★ **low-pressure steam is used.** In a variety of industries, such as oil refineries, chemical plants, and paper and textile mills, turbines reduce high-pressure steam to process pressures while producing low-cost by-product power.
- ★ **reliable drives are essential.** Circulating, condensate, and boiler-feed pumps; forced-draft and induced-draft fans; coal stokers and pulverizers are but a few that require never-failing operation.
- ★ **dependable stand-by power is required** for fire pumps, emergency boiler-feed pumps, exciters, and similar auxiliaries. No preliminary "warming-up" period is necessary.
- ★ **hazards of explosion are present.**
- ★ **a range of speed is required.**
- ★ **the speed must be adjusted automatically** as required, to control pump or fan discharge pressure.
- ★ **unfavorable atmospheric conditions exist,** such as dampness and high ambient temperatures.

It's Easy to See Why

Type D Mechanical-drive Turbines Last the L-o-n-g-e-s-t

With pumps, fans, and compressors required to run continuously for longer periods these days, dependable drives are necessary for defense against shutdowns. To meet today's increased production requirements you'll find it pays to go Type D—to *use G-E mechanical-drive turbines to drive your important apparatus in which some "weak link" may limit production.*

This now-better-than-ever turbine has a strainer to prevent entrance of foreign materials, a combined trip and throttle valve to assure protection against overspeed, and ring-lubricated bearings with the oil supply insulated and cooled by circulating water. Add to these exclusive advantages the chrome-alloy buckets, the dynamically balanced rotor, the sustained efficiency, and the carbon packing glands that reduce steam loss—and you'll realize why Type D drives avoid wasted money and valuable time through shutdowns.

As production gains more speed, more power will be needed. Remember, there's a G-E turbine specialist near who can show you how to get economical power as a by-product of steam. Enlist his help. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

252-6-450

Visibility

PLUS MECHANICAL STRENGTH

When you install a PYREX Broad Red Line Gauge Glass, you can be sure of two things. It will give you greater visibility and it is there to stay for a long time.

PYREX Gauge Glasses are made from tough PYREX brand Industrial Glass. They resist the corrosive action of hot water and steam. They resist the shock of sudden temperature changes. They are machine drawn to uniform accuracy that eliminates installation strains.

The next order you place for gauge glasses try PYREX glasses with the broad red line. They are stocked by all leading steam and mill supply houses.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Today's Fight For Success

• •

To engineers, managers and stockholders of any manufacturing plant or service establishment, the power plant equipment makes up the weapons in today's battle for continuous and successful operation. In a large measure, it controls improvements, economies, dividends.

To gain success and move forward with the great power plant industry calls for a broadened knowledge on the part of operating engineers and managers in the value of the modern methods and equipment as described in the advertisements of this and other issues of POWER PLANT ENGINEERING.

Seybold-Potter Co. of Cleveland, Ohio, one of the country's largest manufacturers of offset printing presses, paper cutting machines and allied machinery.

In 1917, Mr. Hubbard did military service on the Mexican border and later served in France, being discharged from the Army as a second lieutenant.

Upon his return to America, Mr. Hubbard spent a year at the Massachusetts Institute of Technology and then attended Northeastern University in Boston, from which he was graduated with a degree of Bachelor of Mechanical Engineering. His first business experience was in the shops of the Bullard Machine Tool Co., Bridgeport, Conn. This experience led to his completing his formal education with a degree from the Harvard Graduate School of Business.

In 1930, Mr. Hubbard joined the Harris-Seybold-Potter Co. as Comptroller. Subsequently, he assumed the additional duties of Secretary and Treasurer and when he resigned was also a Director of the Company and Managing Director of the Company's Seybold and Canadian Divisions. Mr. Hubbard became President of the Greenfield Tap and Die Corp. about the time the defense program started and he was immediately faced with the difficult problem of substantially increasing the Company's facilities. In less than a year, the new buildings were completed and the machinery installed and the Company's employe rolls increased from 1100 to 2400.

Mr. Hubbard, during his business career, has established an impressive record in the fields of industrial production, finance, marketing and management. His past experience in the manufacture of engineered products will contribute to the operations of Elliott Co., who are established manufacturers of turbines, generators, condensers, centrifugal blowers and other power plant products.

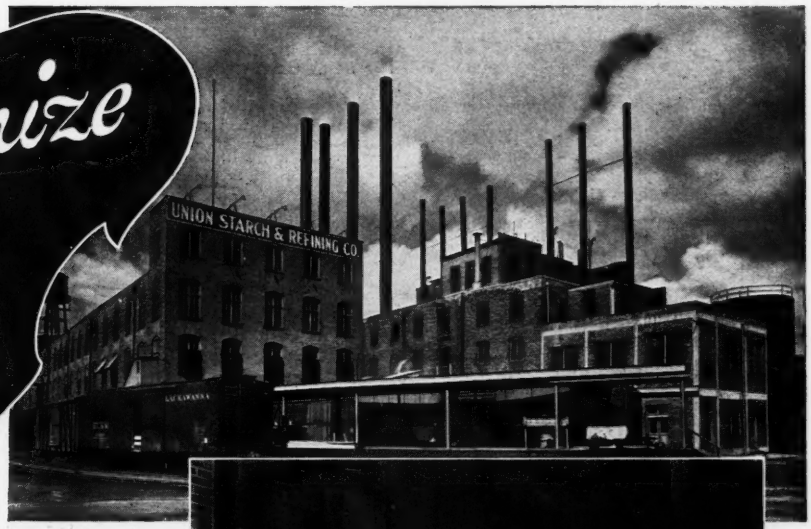
Elliott Co. maintains general offices at Jeannette, Pa., also has plants at Jeannette Pa., Ridgway, Pa., and Springfield, Ohio.

Chain Belt Co. Transfers Representatives

J. WALTER SNAVELY, district manager of the Chain Belt Co. in the Houston territory for 7 yr., has returned to the Sales Department of the Conveying and Engineering Products Division at Milwaukee. Mr. Snavely was graduated from the University of Wisconsin and entered the employ of Chain Belt Co. as a student apprentice in the year 1927. The next 3 yr. he spent in the factory receiving training and experience in the various manufacturing departments.

W. A. Pitts, formerly representative in Oklahoma City, has been appointed district manager of oil well sales at Houston. Mr. Pitts has worked in practically every oil field in the Mid Continent and Gulf Coast area for the past 20 yr. From 1926 to 1934 he was also in the oil fields of California. He has been the Chain Belt Co. Oklahoma City representative in the oil field since 1936.

Modernize with HAYS

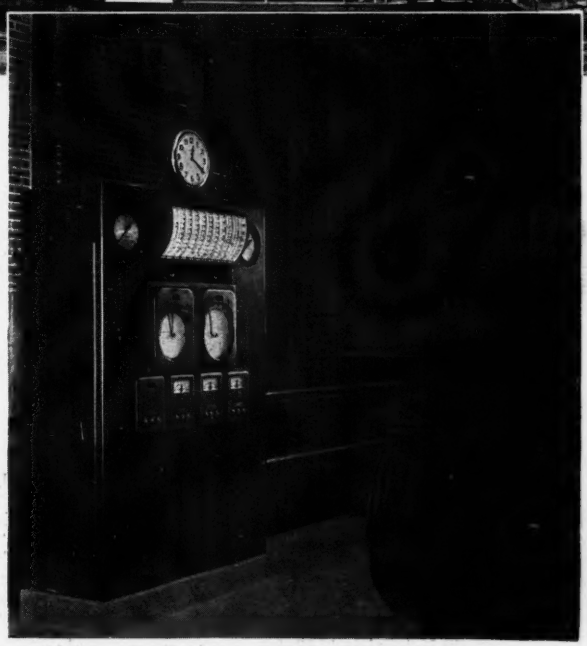


FOR the past 8 or 9 years The Union Starch and Refining Company of Granite City, Illinois, has had a constant problem on its hands to keep its steam generating equipment in pace with its increasing steam demand.

For 30 years steam requirements had been met by six 400 h.p. longitudinal drum boilers fired by natural draft chain grate stokers.

In 1932, in an attempt to meet the ever-increasing load, a changeover to natural gas was made to avoid installing additional boilers. By 1936 the load had increased to peaks of 160,000 lbs. per hour making it absolutely necessary to completely modernize the steam generating equipment.

The first step was the installation of a four-drum Stirling type steam generator at 60,000 lbs. per hr. continuous steaming capacity with 75,000 lbs. per hr. peaks guaranteed for four hour periods. This unit has a nominal rating of 800 h.p. As fast as possible two additional units identical with the first were installed and all were placed under automatic operation through the medium of a Hays Combustion Control System. The control panel for one of the units is shown above.



The Hays system of automatic combustion control holds the steam pressure right on the line in spite of the widely fluctuating load, steaming at times as much as 25,000 lbs. per hr. in excess of its guaranteed 75,000 lbs. per hr. capacity. At the same time a virtually constant CO_2 in excess of 12½% is maintained as well as a constant furnace draft. The fact that all three of these new units are Hays equipment is mute evidence of satisfaction.

Hays engineers will be glad to advise how instruments and control may be applied to your steam generating problems. Write us—no obligation.

ENGINEERS PLEASE NOTE:
Tear off the bottom of this ad and mail with your name and address to The Hays Corporation for copy of "Automatic Combustion Control and its Relation to Lower Steam Costs."

The HAYS CORPORATION
SINCE 1901 — COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

George Hunt has been appointed district manager of industrial sales with headquarters at Dallas, Texas. Previous to his joining Chain Belt Co. organization, Mr. Hunt was an engineer for one of the largest paper mills in the South.

G.E. Personnel Changes

GENERAL Electric Co. reports changes in personnel of the Industrial Department as follows: G. R. Prout has been appointed Manager of Industrial Control Division; R. S. Glenn becomes manager of sales to assist Mr. Prout; W. C. Yates is relieved of duties as manager of control and Renewal Parts to give him more time as assistant manager of the Industrial Department. Mr. Prout's 15 yr. with the company has been largely on motor and industrial control engineering as has Mr. Glenn's work since 1916. E. H. Alexander becomes engineer of the Industrial Control Division, having been with the company since 1928 in Plastics, Industrial Control and Industrial Engineering.

News From The Field

A new 80,000 lb. per hr. boiler purchased from Foster-Wheeler Corp. has recently been installed in the existing boiler house at the Sayles-Biltmore Bleacheries, Inc., Biltmore, North Carolina; also a new Multiple Retort stoker purchased from the American Engineering Co.; both are part of the extensive modernization program totaling upwards of a half-million dollars planned by J. E. Sirrine & Co.

Industrial specialists are needed by the Government with experience in the fields of metals, machine tools, aircraft, railroad repairs, radio, textiles, paper, printing, chemicals, plastics, rubber, leather, at salaries from $2600 to $5600 for various grades. No written examination is given, as applicants are graded on training and experience. Applications and information may be had at any first or second-class post office, from a Civil Service district office or from the Commission, Washington, D. C. Applications will be received for an indefinite period until further notice.

Summer Meeting of the National Association of Fan Manufacturers will be held at Hotel Hershey, Hershey, Pennsylvania, September 4, 5, and 6, 1941, to discuss use of fans, blowers and allied products now being furnished for use of the Navy, Army, and Maritime Commission as well as for factories devoted to airplane and parts, powder and munitions, chemicals, electric power and other defense purposes.

Airport construction, operation and maintenance will be discussed at a conference sponsored by Illinois Institute of Technology at the Palmer House in Chicago on Thursday through Friday, October 30 and 31. "Airports" will be the formal theme of the meeting, which will be the first Fall Engineering Conference of the Institute. It is planned to make the Conference an annual feature with a separate general theme each year, balancing the annual Midwest Power Conference sponsored by the Institute each spring. J. B. Finnegan, professor of fire protection engineering and chairman of the department, will be Conference Director, and C. O. Harris, 8509 Euclid Ave., Chicago, Ill., instructor in mechanics, will be Conference Secretary. Airport grading, drainage and paving, lighting and signaling, capacity and operations problems, airport layout, management, plane servicing arrangements, buildings and fire protection will be among subjects discussed.

Third annual Personnel Conference of the University of Texas will be held Oct. 23-25 at the University. Discussions of defense training, personnel needs, and social security and welfare in the current crisis will keynote the conference, which is in charge of W. R. Woolrich, Dean of Engineering. Addresses are scheduled by Dr. R. L. Sutherland on safety, first aid training, and employee retirement; by Lawrence Appley and by A. A. Potter, Dean of the Purdue University college of engineering.

Exposition of Chemical Industries

M. C. WHITAKER, Vice President of the American Cyanamid Co., is again chairman of the Advisory Committee for the 18th Exposition of Chemical Industries, it has just been announced. The Exposition is to be held in the Grand Central Palace, New York, December 1 to 6, next. Advance registrations already account for practically all of the available exhibit space. Other members of the Committee are: Raymond F. Bacon, L. H. Baekeland, W. S. Landis, President, the Chemists' Club; and Raymond R. Ridgway, President, the Electrochemical Society.

Also included are: J. V. N. Door, President, the Door Co.; Walter J. Murphy, Editor, "Chemical Industries"; H. E. Howe, Editor, "Industrial and Engineering Chemistry"; William L. Evans, President, American Chemical Society; W. T. Read, Dean of Chemistry, Rutgers University; Charles F. Roth, Manager of the Exposition; H. J. Schnell, General Manager, "Oil, Paint & Drug Reporter"; E. K. Stevens, Associate Manager of the Exposition; W. D. Merrill, President, Salesmen's Association of American Chemical Industry; R. Gordon Walker, Vice President, Oliver United Filters, Inc., and E. R. Weidlein, Director, Mellon Institute.

Hotel Heidelberg

HOTEL HEIDELBERG in Jackson, Miss., is being equipped to generate all the electric power used by the hotel. Two 200-hp. Union Iron Works, return tubular boilers have been installed and will operate at about 175 lb. pressure. Two electric generators—220 v., 250 kv-a., each, furnished by the Electric Machinery Mfg. Co. of Minneapolis. Switchboards also are furnished by this company.

Two Ames uniflow steam engines will drive the generators and will exhaust into a Murray Iron Works Type U low pressure turbine which will run condensing. This turbine will drive a 250 ton Carrier refrigeration compressor. Feedwater will be heated by a Hoppes exhaust steam heater if make up is needed.

The boilers will be fired by natural gas and will have oil burners for standby service.

On the fabrication of a steel stack—42 in. diam by 13 ft. high, seams were lap welded with a Lincoln arc welding machine. When the stack is completed it will be hoisted onto a structural steel support by means of a gin pole mounted on the steel work of the building. The pole will have to be 128 ft. high in order to swing the stack.

R. W. Naef, 411 E. Capitol Ave., Jackson, Miss., is architect and engineer.

Heating and Ventilating Exposition

LEADING MANUFACTURERS of heating, ventilating and air conditioning equipment are making active preparations to co-operate in the 7th International Heating & Ventilating Exposition, in Philadelphia, which will be held in Commercial Museum, January 26-30, next.

It is a biennial event, held under the management of the International Exposition Company, of New York, of which Charles F. Roth is president.

Coincident with the dates of the exposition, the American Society of Heating and Ventilating Engineers will convene its 48th Annual Meeting, which is expected to be the biggest and most important in the Society's history. The National Warm Air Heating & Air Conditioning Association and other organizations are also planning to hold meetings at the same time.

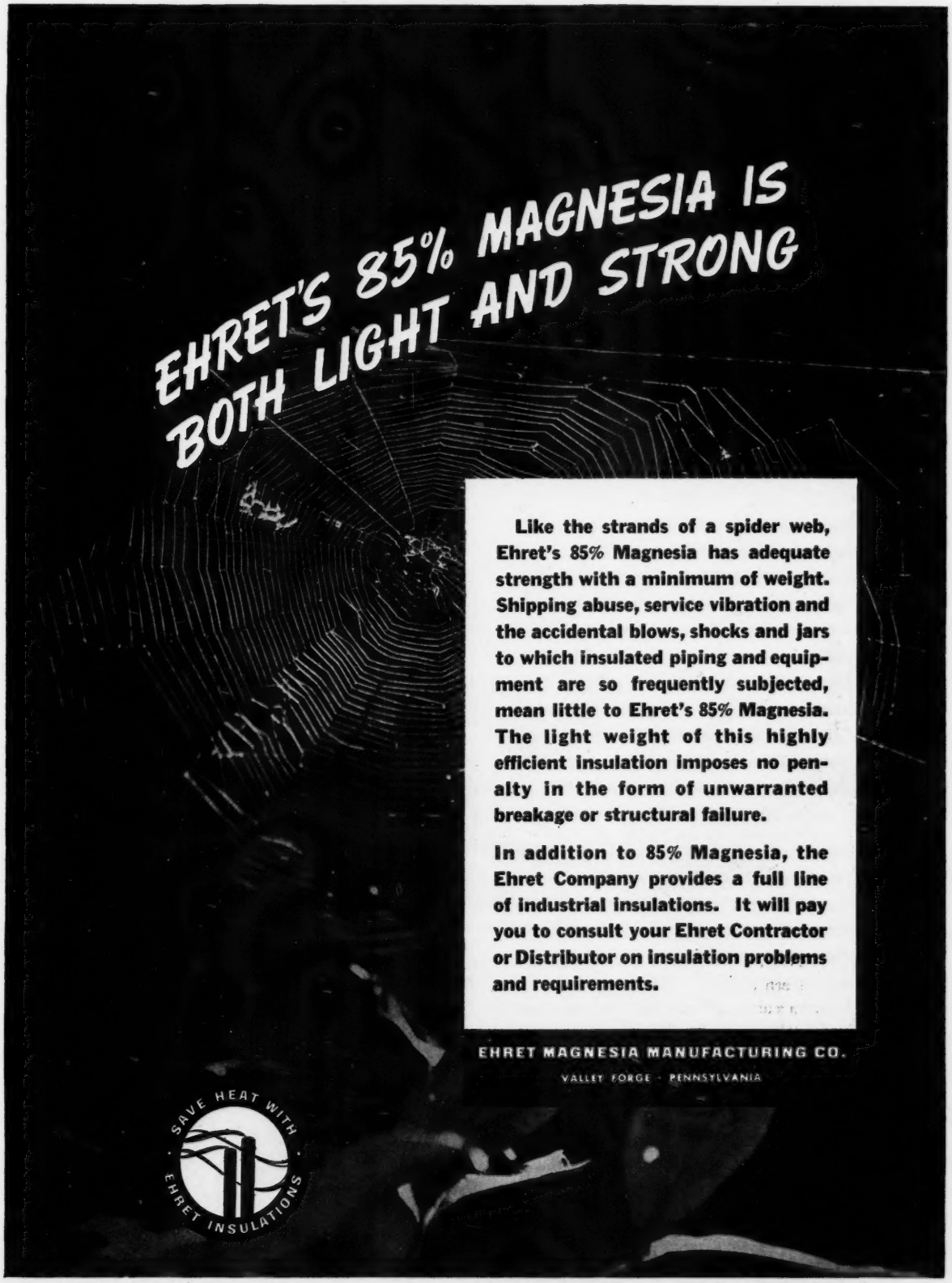
According to a statement by Walter L. Fleisher, President, A. S. H. & V. E., "Recognition of the Society's leadership in research and its allied fields of activity has been given by government departments which require immediate answers to important defense problems. For these investigations, much of the research and capacity of our laboratories have been assigned.

"Because heating, ventilating and air conditioning are essential industries, they enter into every industrial and public building program. For the army camp or home to maintain comfort, efficiency and the health of the occupants heating, ventilating and air conditioning must play an important part. For this reason, the exhibits of manufacturers at the 7th International Heating and Ventilating Exposition takes on increasing importance."

Mr. Fleisher has accepted the chairmanship of the Advisory Committee of the Exposition, according to an announcement by Charles F. Roth, as manager. The Committee includes the following members:

Merrill F. Blankin, Treasurer, A. S. H. & V. E.; John D. Cassell; H. P. Gant, Past President, A. S. H. & V. E.; Charles V. Haynes, Past President, A. S. H. & V. E.; H. Berkley Hedges, President, Philadelphia Chapter A. S. H. & V. E.; John R. Hertzler, York Ice Machinery Co.; Lee P. Hynes, Hynes Electric Heating Co.; Charles S. Leopold, Consulting Engineer; Frederick A. Leser, President, Washington, D. C. Chapter A. S. H. & V. E.; Thornton Lewis, Past President, A. S. H. & V. E.; Frederick D. Mensing, Consulting Engineer; Lawrence E. Moody, Moody & Hutchinson; Albert J. Nesbitt, John J. Nesbitt, Inc.; Lee Nusbaum, Pennsylvania Engineering Co.; J. Earl Seiter, Consolidated Gas, Electric & Power Co.; Thomas H. Urdahl, Consulting Engineer; Warren Webster, Jr., Warren Webster & Company.

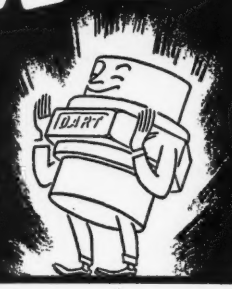
Insulation Facts · Number 4.

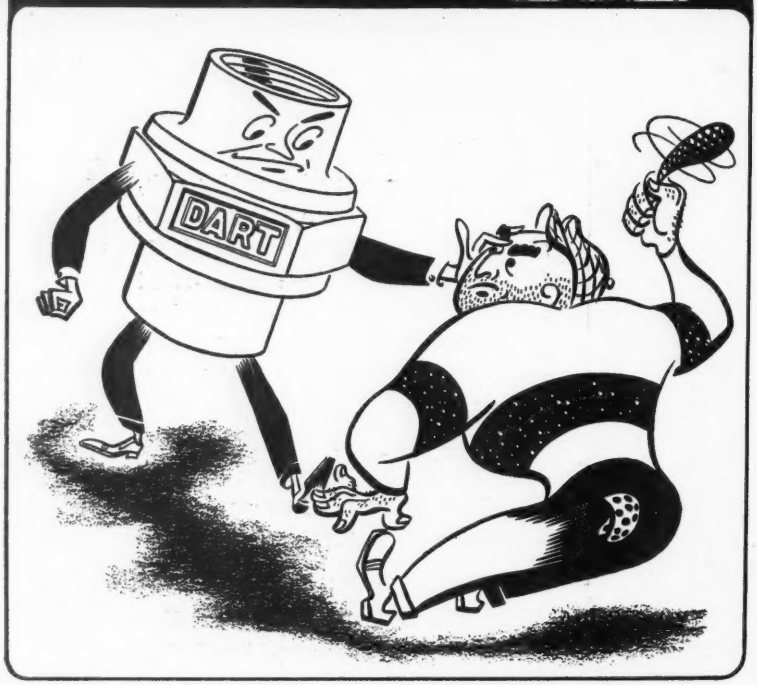

EHRET'S 85% MAGNESIA IS BOTH LIGHT AND STRONG
Like the strands of a spider web, Ehret's 85% Magnesia has adequate strength with a minimum of weight. Shipping abuse, service vibration and the accidental blows, shocks and jars to which insulated piping and equipment are so frequently subjected, mean little to Ehret's 85% Magnesia. The light weight of this highly efficient insulation imposes no penalty in the form of unwarranted breakage or structural failure.
In addition to 85% Magnesia, the Ehret Company provides a full line of industrial insulations. It will pay you to consult your Ehret Contractor or Distributor on insulation problems and requirements.
EHRET MAGNESIA MANUFACTURING CO.
VALLEY FORGE · PENNSYLVANIA
SAVE HEAT WITH EHRET INSULATIONS

MAKERS OF INDUSTRIAL INSULATIONS FOR MORE THAN 40 YEARS

DART UNIONS

RESIST
Rough Handling and Abuse





DART UNIONS won't take a licking from the *toughest* conditions. They're made of stern stuff . . . their matched seats, in fact, are made of *bronze,* ground to accurate "true-ball" surfaces—nuts and bodies are made of air refined malleable iron. This explains why Dart Unions are able to make up tight so quickly, stay tighter longer, be installed time and again. It also explains why Dart Unions can stand up against and KO wrench abuse, pipe strains and corrosion.

If you are not using Darts now, try them soon. You'll be very glad that you did.

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

Utah Copper Co. to Build Power Plant

THE UTAH COPPER CO., Salt Lake City, Utah, has authorized plans for a new steam-electric generating station for operation of its copper properties at Garfield, Utah, including the Magna and Arthur concentrating mills, to be located on site in vicinity of the latter units. The new plant will be equipped for an initial capacity of 75,000-kw., divided into two or three turbine-generator units, with high-pressure boilers and complete auxiliary equipment, including stokers, coal and ash-handling apparatus, as well as power substations, feeder lines, and other operating facilities. It is expected to award contracts for equipment in near future and proceed with actual work on project, to insure completion early in the spring of 1943. Entire development is estimated to cost about $5,000,000. With the operation of this new station, the company will discontinue service heretofore secured from the Utah Power & Light Co., and with which an existing contract expires about the middle of 1943. D. D. Moffat is vice-president and general manager.

Kansas Ordnance Plant

JOHNS-MANVILLE CORP., through its President, Lewis H. Brown, has announced that the Corporation has completed a contract Thursday (August 21) with the War Department to proceed at once with the construction and operation of a $27,000,000 shell-loading plant, near Parsons, Kansas.

This plant will be known as the Kansas Ordnance Plant. It will cover 25 sq. mi., comprise about 400 buildings, 75 mi. of track, and 100 mi. of road, cost about 27 million dollars, and employ 8000 persons. Although foreign to the Corporation's experience, Mr. Brown states that after a careful study of the problem by J-M officials and engineers, and "in spite of the hazards, we have concluded we can do this work, and that our duty requires us to do it. We have therefore decided, with the approval of the Board of Directors, to sign a contract with the War Department under which we will proceed at once."

Battey & Childs, Chicago, Ill., and Consoer Townsend & Quinlan, Chicago, Ill., are the architect-engineers, and Peter Kiewit Sons' Co., Omaha, Nebraska, Geo. W. Condon Co., Omaha, Nebraska, and Paschen Contractors Inc., Chicago, Ill., the construction contractors. In order to keep these operations separate from our regular business, a subsidiary known as J-M Service Corp. has been organized. The cost of the work, including working capital, will be financed by the government. Construction will probably require a year; operation thereafter will depend upon the wishes of the War Department.

Lansing Plans Power Expansion Program

BOARD OF WATER and Electric Light Commissioners, Lansing, Mich., Otto E. Eckert, general manager, has plans nearing completion for expansion in municipal power plant on Ottawa Street, practically doubling the capacity of this station, which was completed and placed in service in January, 1940, at a cost of

EVOLUTION of the BUTTERFLY VALVE

LOW-COST CONTROL OF AIR, GAS, STEAM, LIQUIDS AND SEMI-SOLIDS

The low first cost, ease of control and low pressure loss have made the Butterfly Valve ideal for hydraulic service, where it has been successfully operated under high pressure for many years.

R-S Butterfly Valves have been developed to a high state of efficiency and are now used in many services to replace more expensive and less satisfactory valves of the conventional type. They not only close as tightly as double seated valves but are self-cleaning and require less supporting structure and space because of their comparatively light weight and compact construction.

In addition to the standard line of precision-made, manually-operated valves, the R-S Butterfly Valve is adapted to automatic operation under high or low pressures and temperatures. Sizes from 2 to 72-inches. Such automatic operation is by means of floats, electric motors, solenoids, steam, compressed air, hydraulic or remote control systems.

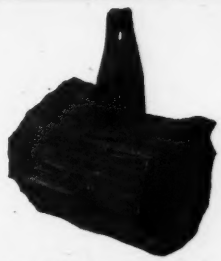
Either or both bodies and vanes are manufactured from any required metal or alloy to meet special operating requirements. These applications include high and low pressures and temperatures for the accurate flow control of oil, vapors, air, gas, steam, water, chemicals, paper pulp or any other material that flows or can be forced through a pipe.

Extended stuffing boxes and shafts, ball bearings and rotary seals are frequently furnished as well as special linings such as rubber, or cadmium plating.

Consult with experienced R-S Engineers, pioneers in the development of the Butterfly Valve. Write for Bulletin 8-B.

R-S PRODUCTS CORPORATION
4535 Germantown Ave., Philadelphia, Pa.

R-S BUTTERFLY VALVES



Section of Wooden Water Pipe, with Iron Control, Laid in New York City by the Manhattan Water Company Early in the 19th Century.
(Courtesy of the New York Historical Society, New York City)

Precision-Made Butterfly Valve with Hand Lever Control.

Hand Wheel Operated.

Automatic Operation by Hydraulic Cylinder for Close Control of Flow.

Chain Wheel Operated. Also Available for Chain Lever Operation.

Why take chances on dirty, oil-soaked or wet insulation, when you can test it so easily?
Insurance Engineers take no chances
WHY SHOULD YOU?
Photo by Courtesy of Eagle-Globe-Royal Indemnity Companies and Pennsylvania Sugar Company

When the engineers of the Eagle-Globe-Royal Indemnity Companies make a periodic inspection of electrical equipment which they insure, they take no chances on the insulation — they test it with a "Megger" Insulation Tester.

By this simple procedure and without risk of unnecessary breakdown, they penetrate unseen conditions caused by dirt, moisture and deterioration, and decide whether the insulation is in good or poor condition.

Hundreds of thousands of similar recorded tests made by leading Insurance Companies, as well as tests made independently by Operating Engineers, have shown that periodic insulation testing is an indispensable procedure for preventing unexpected electrical breakdown and unnecessary outages and repairs.

Why take chances? Whether you carry electrical insurance or not, you want to avoid electrical breakdown. "Megger" testing is the practical way to go about it.

"MEGGER"
TRADE MARK REGISTERED U S PAT OFF.

Write for a copy of our Pocket Manual of "Megger" Practice, No. 1420-PE.

James G. Biddle Co.
1211-13 ARCH STREET Electrical and Scientific Instruments PHILADELPHIA, PA.

about $4,000,000. A new multi-story addition will be constructed at the north side of the existing structure, with the installation of a new 25,000-kw. turbine-generator unit and accessories, high-pressure boiler and auxiliary equipment. Switching facilities will be enlarged and extensions made in transmission and distributing lines in different parts of city, including power substation units and service connections for additional consumers. The entire program is estimated to cost close to $3,000,000, and is scheduled to be placed under way at an early date.

Goodrich to Construct Ordnance Plant

ORGANIZATION of the Lone Star Defense Corp., a subsidiary of the B. F. Goodrich Co., Akron, Ohio, to immediately engage in the construction and operation of a $35,000,000 government ordnance plant to be established near Texarkana, Texas, is announced by John L. Collyer, company president.

The ordnance plant will be located on a tract of land comprising more than 24,300 acres seven miles west of Texarkana. Approximately 8000 people will be employed in the construction of the plant, where shells and bombs will be loaded, it is reported.

Directors of the new defense company are: Mr. Collyer, T. G. Graham, G. W. Vaught, S. M. Jett and L. L. Smith, of Akron, Ohio., officers of the B. F. Goodrich Co.

Arthur Kelly, named general manager of the ordnance plant, has been with B. F. Goodrich since 1925 shortly after his graduation from Purdue University. After assignments in various manufacturing operations in the company's principal factories in Akron, Kelly went to the California plant of the company for a year and from there to foreign plants representing B. F. Goodrich. On his return to the United States, he became manager of the company's tire factory at Oaks, Pa., and when the company's mechanical goods division was completed in Clarksville, Tennnessee, became its first manager. Returning to Akron this year, he became general superintendent of the Mill 4 division of the company, which position he leaves to take his new post.

Joseph C. Herbert, assistant secretary of the new defense company, has been manager of the Los Angeles plant of the company. He joined B. F. Goodrich in 1927, went to Los Angeles the following year as secretary of the Pacific Goodrich Rubber Company, returning to Akron in 1931 as assistant counsel. He returned to California in 1936.

Kenneth R. Huffman, appointed controller of the defense subsidiary, has been with the parent company since 1919 and was manager of the tire cost department at the time of his appointment to his new position.

Arthur C. Sprague, manager of the company's labor department, will be personnel superintendent in the Texas ordnance plant. He joined the Akron company in 1916 shortly after his graduation from Carnegie Institute of Technology. He became a member of the labor department and was made manager in 1927.

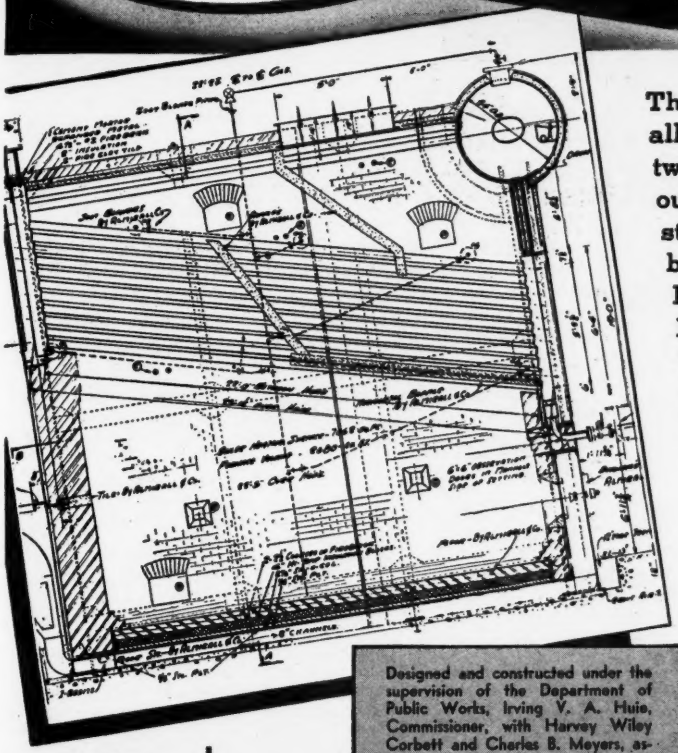
J. W. Frasche, now purchasing agent in the company's California plant, will

Served by

4 VOGT

Forged Steel

SECTIONAL HEADER BOILERS



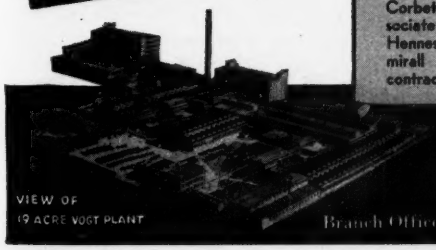
Designed and constructed under the supervision of the Department of Public Works, Irving V. A. Huie, Commissioner, with Harvey Wiley Corbett and Charles B. Meyers, associate architects, and Syska & Hennessy, consulting engineers. Almirall & Company, Inc., heating contractors.

Thirty Court Rooms and Jury Rooms, all completely air conditioned, and a twelve story Prison are housed in this outstanding Public Building. All the steam requirements will be supplied by four Vogt Sectional Header Boilers.

Each steam generating unit has 7,062 sq. ft. of heating surface designed to generate 47,000 pounds of steam per hour at 200% rating, using oil for fuel. Headers, forged from seamless steel tubing, and the fusion welded steam drum are designed for 200 pounds working pressure.

•

Vogt builds steam generating equipment in many types and sizes to meet every heating, power, or processing requirement.



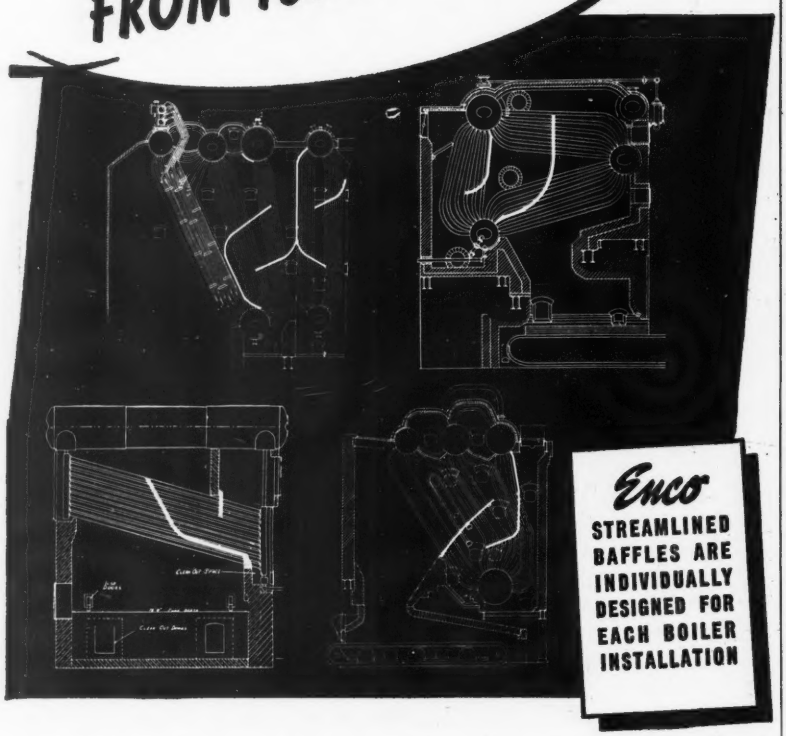
VIEW OF
19 ACRE VOGT PLANT

HENRY VOGT MACHINE CO., Inc.

LOUISVILLE, KY.

Branch Offices: New York · Philadelphia · Cleveland · Chicago · Cincinnati · St. Louis · Dallas

THE Quickest WAY TO GET MORE STEAM FROM YOUR BOILERS



RIGHT now, when most power plants are taxed to the limit, the type and construction of the baffle walls in your boilers are of the utmost importance.

That much needed extra capacity, plus lowered operating and maintenance costs can be obtained by the installation of ENCO Streamlined BAFFLE WALLS. We've spent 25 years perfecting baffle wall design and materials to a point where they greatly influence boiler performance.

Write for Bulletin BW-40 or, for quick action, send blue prints and operating data. There is no obligation.

THE ENGINEER COMPANY
75 WEST STREET • NEW YORK, N. Y.

Enco Streamline Baffles
PRODUCED EXCLUSIVELY BY THE ENGINEER COMPANY

be purchasing agent for the new company. He was hired by B. F. Goodrich in 1928 following his graduation from Iowa State College.

C. E. Jones, now company plant engineer at Oaks, Pa., will be chief engineer for the defense corporation. He is a graduate of University of Virginia, joined B. F. Goodrich in 1928 and was a member of the engineering division in Akron before going to the company's branch plant.

Prack and Prack and the Chester Engineers of Pittsburgh, Pa., will be architect-engineers, it is announced, and the Winston Brothers Co., Minneapolis, Minn.; the C. F. Haglin Sons Co., Minneapolis, Minn.; the Missouri Valley Bridge & Iron Co., Leavenworth, Kans.; and the Sollitt Construction Co., South Bend, Ind., have been awarded contracts as construction contractors.

Central Valley Project

THE BUREAU of Reclamation, Denver, Colo., has an appropriation of $34,750,000 for the Central Valley project, Calif., for the fiscal year 1941-42. The work scheduled for this 12 mo. period, absorbing this amount will include contracts for a fifth hydroelectric generating unit of 75,000 kv-a. rating for the Shasta power plant (for which bids are now being asked), and three 45,000 kv-a. units for installation in the Keswick dam generating station; continuance of construction on the Shasta and Friant power dams; commencing the first stage of construction for the Keswick dam, which will be of concrete gravity-type, 80 ft. high, and initial work on power station at this dam, as well as fish-trap; continuance of construction of Madera and Contra Costa canals; relocation of public utilities at Shasta reservoir, and completion of track relocation of the Southern Pacific Railway; migratory fish control facilities at different points; clearing of Shasta reservoir site; and miscellaneous work. The entire development, located in northern California, will require a number of years for final completion and is estimated to represent a total investment of $263,990.

Grand Coulee Hydraulic-Generators Contracted

THE BUREAU of Reclamation, Washington, D. C., has awarded contract to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for three 108,000 kv-a. electric generating units for installation in Grand Coulee hydroelectric generating station, Grand Coulee, Columbia Basin project, Wash., at $2,697,785, f.o.b. East Pittsburgh. An award for three hydraulic turbines, each 150,000-hp. rating, to operate generators noted, has been placed with the Newport News Shipbuilding & Drydock Co., Newport News, Va., at $1,880,000. Order for three governors for the hydraulic turbines has been given to Woodward Governor Co., Rockford, Ill., at $82,992, including pumping equipment and accessories.

Additions to generating capacity of Public Service Electric & Gas Co. of N. J. are announced as follows: Put in service July 29, 1941, 50,000-kw. h.p. unit at Marion Station; for completion late in 1942, 50,000-kw. l.p. unit at Marion; for completion in late 1942 100,000-kw. unit for Burlington Station. When these are completed, total capacity of the system will be 1,037,700 kw.

"VALVE MAINTENANCE AT A MINIMUM"

says American Extract Co., *another* DARLING *user*

"We have used Darling Double Disc Gate Valves for over 13 years and have found them to operate better than any other valve. On our tannic extract lines . . . crystals cause severe stem strains when valves are opened. Darling construction and wedge-release feature keep valve maintenance costs at a minimum.

"Double revolving parallel discs eliminate excessive wear. Working parts are easily replaced without removing the valve from the line . . . we are able to eliminate loss of partly processed extracts."

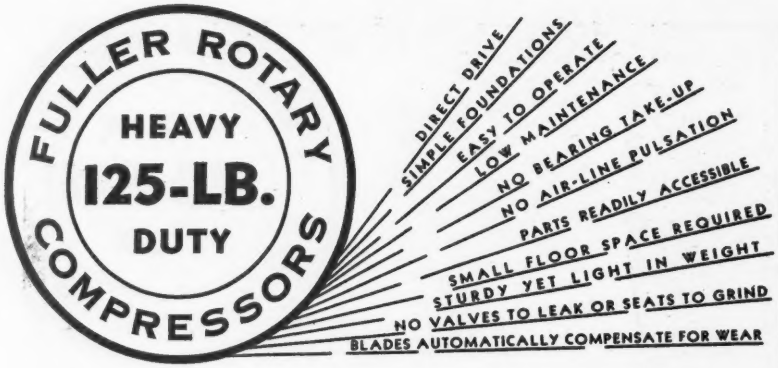
J. L. Barren, Gen. Supt.
American Extract Company

Letters like this speak for themselves as evidence of Darling advantages — long life, easy operation, low maintenance costs.

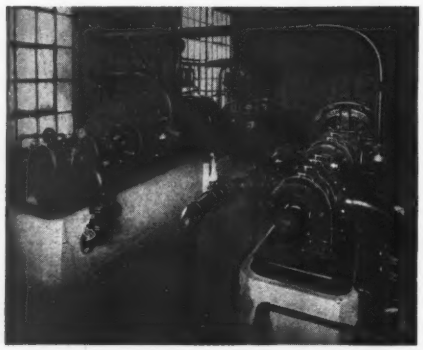
Darling Gate Valves for every purpose are available in cast steel, forged steel, cast iron, bronze and in a wide range of alloys specially developed for use under severe service conditions.

DARLING VALVE & MANUFACTURING CO.
WILLIAMSPORT, PA.

Representatives in:
New York McPherson, Kan. Houston Philadelphia Toledo Huntington, W. Va. Pittsburgh

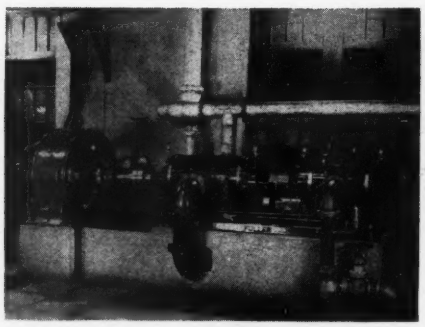


Actual operating experience demonstrates reliability of Fullers . . . available for 80 to 125-lb. service.



Left: **750 C.F.M.** each, actual free-air delivery, **100 lb. pressure,** Two-stage Rotary Compressors, installed March, 1931, in a cement plant in Pennsylvania. Plant records show that these two machines have given excellent service. One machine was operated a total of 35,162 hours and the other 23,567 hours with no maintenance cost whatsoever. More proof that Fullers are really built for 100-lb. service, with ample safety factor to spare.

Right: **1000 C.F.M.** actual free-air delivery, **110-lb. pressure,** Two-stage Rotary Compressor, installed in a tin-plate mill in Pennsylvania. This machine has been in operation over seven years, during most of this time being on six days a week, 24-hour per day service, shutting down only on Sundays . . . and this service secured with a very low cost for maintenance and repairs.



Write for Bulletin C-3A

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C50

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

MANUFACTURERS' NEWS

General Electric Co. has built a warehouse and service shop at Pittsburgh, Pa., with 50,000 sq. ft. of floor area, 15-t. crane service, dust and fume elimination, hydraulic press, cleaning booth and copper reclaiming oven. Fluorescent lighting is used, gas-fired heating plant and basement testing laboratory.

Merger has been authorized by Federal Power Commission of Union Public Service Co. of St. Paul with Otter Tail Power Co. of Fergus Falls, Minn. Issue of $5,400,000 of 30-year, 3 per cent bonds is authorized, to redeem Union Public Service Co. bonds and refund Otter Tail Power Co. bonds. Stock of Otter Tail Power Co. will be issued in exchange for stock of Union Public Service Co.

In the case of Chicago District Electric Generating Corp., rehearing has been asked of Federal Power Commission on its order to base reduced rates on valuation established from the prudent investment theory. Loss of revenue to the Chicago District Co. would exceed $1,000,000 a yr.

E. J. Cheney and Company, consulting engineers, of 61 Broadway, New York, have prepared a brochure outlining the scope of their services to industrial, construction and public service organizations and for the development and direction of public works enterprises. It indicates a broadened range of functions to meet the needs of the defense program, financing for expansion and modernization and for the handling of corporate records and accounts to fit the regulations now prevailing.

The Foxboro Co. has changed the address of its St. Louis, Mo., office to 3615 Olive St., phone Newstead 5222. E. B. Miller, formerly of the Chicago office will be in charge, with R. H. Hemfelt as assistant. E. R. Huckman formerly at St. Louis has been transferred to New York territory.

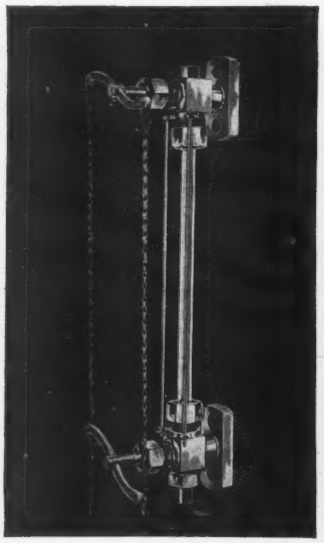
Cochrane Engineering Co., 53 W. Jackson Blvd., Chicago, Illinois, has been appointed by American Engineering Co., Philadelphia, as its sales representative for stokers and waterwalls in Northern Illinois, Northern Indiana, and Iowa. G. J. Zanke of the Chicago office of American Engineering Co. is now associated with the Cochrane Co.

Peerless Pump Division of Food Machinery Corp. has removed its Eastern offices and plant to 1250 Camden Ave., S. W., Canton, Ohio, management being under Vernon Edler, vice-president.

The Aluminum Co. of America announces that negotiations have been completed and a contract made with Defense Plant Corp. acting for the United States for the construction and operation of an aluminum plant in the State of Arkansas with an annual capacity of 400,000,000 lb., and for the construction and operation of three

SCIENCE at your SERVICE
The correct answers to the valve problems of modern American industry are not always to be found in a catalog. New temperature ranges, new chemicals, new pressures often impose requirements on the valve setup which must be treated as original research projects.
For many years Powell engineers have solved problems of this nature as they have arisen in the forward march of American industry. These answers are to be found in the Powell catalog. As to the new problems which are coming up with ever-growing frequency, Powell engineers stand fully equipped and ready to solve them with the same scientific certainty that has marked their technical accomplishments in the past.
The Valve shown here is a Class 900 lb. cast alloy steel gate valve for operation on 900 lb. W. P. Steam Lines at 875° F. Seats and discs are hard faced with Stellite. Ends are machined for welding. It is a splendid example of a valve, specially designed to meet a specific industrial use in accordance with the rigid requirements of Powell technical procedure.
The Wm. Powell Company
Cincinnati, Ohio
POWELL VALVES

"PSH" Tiltview Gauge (patented)



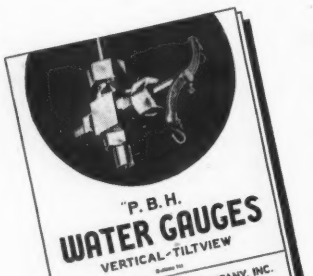
"PBH" Vertical Gauge

HUYETTE WATER GAUGES
Vertical—Tiltview

During the past forty-five years, our activity has been devoted to designing and manufacturing a complete line of water gauge valves. The wide use of "PBH" Gauges during this period indicates that industry does appreciate quality. Our high standards of material, workmanship and inspection continue today on an ever-increasing scale.

All "PBH" valves are polished, well proportioned, of heavy bronze alloy according to A. S. M. E. Code and stamped with maximum working pressure. Glass and stem nuts are large to accommodate ample size packings, insuring steam-proof and leak-tight service.

"PBH" Tiltview Gauges are recommended for easier visibility when gauges are high above the operating floor. Tiltview offset right or left hand—at 30° inclination.



GET THIS DATA SHEET!

Our new bulletin No. 741 gives complete data and specifications on all "PBH" Water Gauges. Sizes, working pressures and pipe connections are included together with complete illustrations. Your letterhead will secure you a copy—write today.

THE PAUL B. HUYETTE CO., INC.
Established 1896
401 N. Broad St., Philadelphia, Pa.

aluminum smelting plants, one at Massena, N. Y., with an annual capacity of 150,000,000 lb., another in the Portland-Oregon district with an annual capacity of 90,000,000 lb., and a third in Arkansas with an annual capacity of 100,000,000 lb. Announcement is also made that the price of ingot aluminum will be reduced from 17 cents to 15 cents per pound on shipments made after September 30.

For compact, new or expanding plants, J. L. McKeever, general engineer of Canadian General Electric Co., Ltd., advocates use of a low-voltage network. In his plant at Peterborough, Ont., power from a steam-turbine generating unit, from two small hydroelectric stations and from the city Utilities Commission was paralleled in the steam-plant switch room and the power fed by 6600-v. underground cables to four step-down substations from which it was sent out at 575 v. for power and at 115/230 v. for lighting. The space served was 790 000 sq. ft. For the extension of 370,000 sq. ft. a distribution was adopted of nine unit substations, connected to the 6600-v. loop and with 575-v. secondaries supplying the network. Cost saving over a radial system was estimated as 18 per cent, with less transformer capacity, simplicity and better voltage regulation.

OBITUARIES

George L. Markland, Jr.

GEORGE L. MARKLAND, JR., nationally known machine tool authority and president since January, 1935, of the Philadelphia Board of Trade, died August 14 in Jefferson Hospital at 73 yr. of age, after an illness of several months.

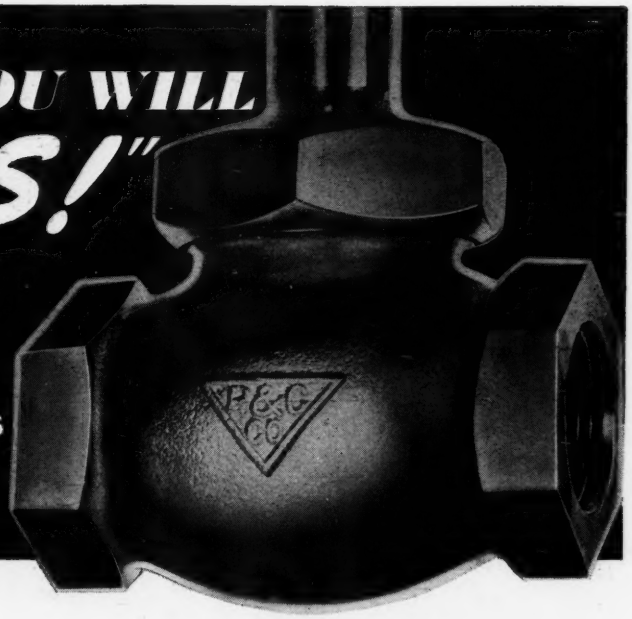
He made his reputation in business at the Philadelphia Gear Works, at G St. and Erie Ave., succeeding George B. Grant. At the time of his death he was serving as chairman of the board of this plant.

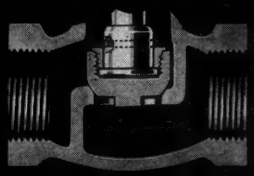
He was former president of the American Gear Manufacturers' Association, a former director of the National Association of Manufacturers and the National Metal Trades Association, and was a member of the American Society of Automotive Engineers, the Machinery Club of New York and the Engineers Club of Philadelphia.

M. J. Tennes, Sr., who has served as Chairman of the Board of Directors of Shafer Bearing Corp. since 1934, passed away recently. Surviving are his widow Ida B. Tennes, daughter Dorothy and three sons; Capt. M. J. Tennes, Jr., president of the corporation, now on active duty in the Army Air Corps, R. P. Tennes, secretary-treasurer and a director of the corporation, Ensign H. E. Tennes, also a director, now on active duty in the Navy Air Corps.

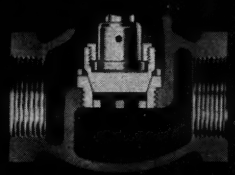
WE BELIEVE YOU WILL ANSWER "YES!"

to these 3 Questions about Your Bronze Globe and Angle Valves

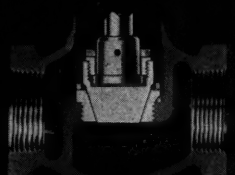




BRONZE REGRINDING GLOBE VALVES



BRONZE SEMI-PLUG GLOBE VALVES



BRONZE FULL PLUG GLOBE VALVES

1 Would it help solve some of your valve troubles if stems of Bronze Globe and Angle Valves were stronger—processed to give exceptional resistance to corrosion—made of naval bronze for great resistance to galling, seizing and wear?

2 Would it cut your cost of valve maintenance if seats and discs were harder? Do you want greatest resistance to galling and seizing, as well as to damage by foreign matter in the line?

3 Would it make it easier for you to select valves if you could find these and other matching qualities in *one family* of Bronze Globe and Angle Valves—in one family that includes valves designed for each *type* of service—150 lbs. to 350 lbs.?

You will find what you want, then, in Pratt & Cady Bronze Globe and Angle Valves—*now, in every detail of design and materials in line with the great needs of today*. Write for details of this great line of Bronze Globe and Angle Valves.

•

FOR GENERAL SHUT-OFF SERVICE—Or for occasional throttling air, hot water and saturated steam. Pratt & Cady Regrinding Valves. Ratings, steam: 125 lbs., 200 lbs., 250 lbs., 300 lbs. Screwed and flanged ends.

FREQUENT THROTTLING—Also for bleeder connections, boiler feed line, railroad, marine, oil refinery and other services where ordinary valves wear out quickly. Pratt & Cady 300 Brinell Semi-plug type Globe Valve. Ratings, steam: 200 lbs. and 300 lbs. Screwed and flanged ends.

SEVERE THROTTLING—At maximum rated pressures and temperatures. Exceptionally wide seating contact. Seats and discs of extreme hardness to resist damage by grit in the line—heat treated to prevent galling. Pratt & Cady 300 and 500 Brinell Full plug Globe Valves. Ratings, steam: 150 lbs., 250 lbs., 300 lbs. and 350 lbs. Screwed and flanged ends.

R READING
CAST STEEL VALVES & FITTINGS

P&C PRATT & CADY
BRASS & IRON VALVES

D'ESTE
VALVE AND ENGINEERING SPECIALTIES

READING-PRATT & CADY

READING, PENNSYLVANIA

ACCO

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

New Engineering Books

Mechanical Engineering Practice. By Charles F. Shoop and George L. Tuve. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Third edition, copyrighted 1941. Size 6 by 9 in., cloth bound, 463 pp. plus 30 pp. of tables and data. Price $4.00.

This is designed as a laboratory reference text for schools and covers some 93 practical laboratory experiments covering the entire mechanical field of measurements, lubricants, heat transfer, gasses, fluids, pumps, compressors, steam generating equipment and auxiliaries, refrigeration and internal combustion engines. The unusual amount of explanation for a book of this kind, with references and correlation with new standard test codes makes this a valuable reference book for the engineer's library, quite aside from its value as a text.

The new edition follows the same general arrangement of a self contained volume as the earlier editions but has been materially expanded. Much more performance data, more tables and charts are included, supplemented by some 100 suggested forms for laboratory data and results.

Results of Municipal Electric Systems. 7th edition. 428 pages. 6 by 9 in. Flexible, patent binding. Published by Burns & McDonnell Engineering Co., Kansas City, Mo., 1941. Price $5.00.

An electric rate book showing the operating records of earnings, output, rates, revenues, valuation and other information regarding the use and cost of electricity in 758 municipally owned systems.

The volume is accompanied by interesting graphs and tables showing the rates and revenues, also facts pertaining to the increasing use of electricity and the decreasing cost of electricity in municipal installations.

City officials, operators, and managers of both private and municipal systems will find these operating records of much interest and value. Over half the systems in the country have lowered rates since the former 1939 edition. A majority of the cities have no bonded indebtedness on their municipal systems. The type of plant and its management are recorded.

Every complete and authentic record received from municipal systems has been recorded. Therefore, it is a fair, unbiased cross-section of what municipally owned systems are doing.

It is the only book of the kind published, and as a reference is indispensable to every city official or electricity user who wants to keep abreast of the rapidly changing power rates and conditions.

Bibliography of Relay Literature 1927-1939. 16 pages, 8½ by 11 in. pamphlet. Published by the American Institute of Electrical Engineers, 33 W. 39th St., New York, N. Y. 25c per copy to members of the Institute, 50c to non-members.

This special publication was sponsored by the AIEE committee on protective devices and was prepared by a working group of the relay subcommittee. This subcommittee reviewed available indexes and from these compiled this list of significant articles dealing with protective relaying and also with closely related subjects, including all such material published in AIEE Transactions or Electrical Engineering from January 1927 through December 1939, and most of that in the principal technical publications of the world from January 1932 to December 1939.

The 450 odd annotated reference items are divided into the following subject sections, and in each section entries are consecutively numbered and listed alphabetically by years: Line Protection (Distance, Pilot Wire and Carrier Current, Ground Faults, General), Bus Protection, Apparatus Protection, Distribution and Network Protection, Service Restoration, General and Miscellaneous Relaying, Testing and Analyzing, System Stability, Methods of Calculation, and Instrument Transformers and Other Auxiliary Devices.

(Continued on Page 140)

FISHER
PUMP GOVERNORS
Champions SINCE
1880
It was back in 1880 that William Fisher gave the industry its first automatic control for steam driven pumps. That Fisher Type 1 Governor, improved by better metals and modern machining, but unchanged in principle, is still the outstanding pump governor on the market today and is so recognized by engineers everywhere. Sound engineering, quality materials and skilled workmanship have made this 60-year record for dependability possible.
Having set the pace with the first pump governor, Fisher Governor Company has proudly maintained that lead through the years with new designs to meet industry's ever growing needs. Today we offer the most complete line of pump governors on the market — and, every one incorporates those same qualities that have made the Type 1 Governor a champion for 60 years.
In addition to those illustrated, Type 57 Diaphragm Actuated Governor — Type 516 Multiple Spring Governor — Types 56 and 53 Oil Pump Governors — Type 4 Excess Pressure Governor, and many others for all classes of service.
WRITE FOR CATALOG B FOR COMPLETE DETAILS
TYPE 1 Constant Pressure Governor
TYPE 3 Constant Hydraulic Pressure Governor
TYPE 444 Excess Pressure Governor
TYPE 84 Vacuum Pump Governor
TYPE 4357 Pilot-Operated Pump Governor
FISHER
GOVERNOR COMPANY
1004 Fisher Building
MARSHALLTOWN, IOWA

HERE'S HOW TO GET GREATER OUTPUT FROM POWER-PLANT EQUIPMENT ... AT LOWER COST

PARTIAL LIST OF J-M INSULATIONS

For steam lines up to 600° F.
J-M 85% Magnesia Pipe Insulation

For boiler surfaces to 600° F.
J-M 85% Magnesia Blocks

For cold rooms, ducts and refrigerating equipment
Rock Cork Sheets

For refrigerated piping
Rock Cork Pipe Insulation

For cold-water lines
Anti-Sweat Pipe Insulation

For hot or cold service-water lines
Pre-Shrunk Wool Felt Pipe Insulation

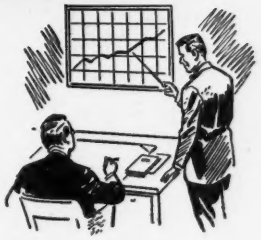
For low-pressure steam lines
Pre-Shrunk Asbestocel Pipe Insulation

For steam lines to 700° F.
Asbesto-Sponge Felted Pipe Insulation

For superheated steam lines
Superex-Magnesia Combination Insulation

For furnace insulation
Superex Blocks, Insulating Brick (3 types), Insulating Fire Brick (4 types), Sil-O-Cel C-3 Concrete

Other insulations for special requirements

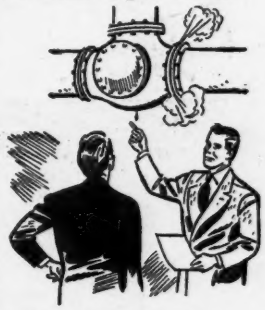


Even though your power-plant equipment is pushed far beyond its normal rating and is operating at greater capacity than ever before—here's how you may get even larger returns from every ton of fuel you burn.

Check up on your insulation!

There's a good chance that a careful investigation today may reveal unsuspected sources of wasted heat—lost efficiency—that heretofore have gone unnoticed, or unattended, yet which, when corrected, may materially increase the output of your plant.

For example: Are all the flanges and fittings in your steam lines fully insulated? Are gaskets sound and tight? A leak here may allow moisture to creep under the pipe insulation and greatly decrease its efficiency. How about boiler tops? Unless the insulation is in good condition, you are losing heat, wasting fuel. If any of your equipment is exposed to weather, make sure the weatherproofing has not loosened and left the insulation unprotected.



These are just a few of the potential sources of wasted fuel and lost efficiency that may exist in any power plant. To make sure that you catch every one, and stop the trouble before it goes too far, Johns-Manville offers you, without charge, the services of a trained, experienced insulation engineer. For full details on this helpful service, and for facts on the complete Johns-Manville line of power-plant insulations, write Johns-Manville, 22 E. 40th St., New York, N. Y.

JM Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE... EVERY SERVICE CONDITION

ADVERTISING PAGES REMOVED

NO ORPHANS

Among ROTO TUBE CLEANERS

Model 120 tube cleaner for 2½" curved tubes

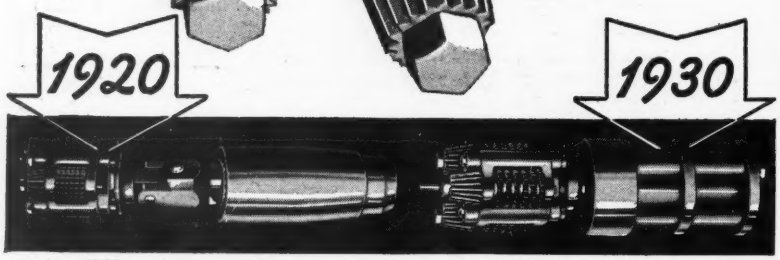
No Roto owner has ever had to scrap his tube cleaner because of inability to secure repair parts in the last 30 years. It is a tribute to the durability of Roto Tube Cleaners that so many of them are outliving the equipment for which they were purchased.

We have complete records, drawings or illustrated parts lists of every one of the thousands of Roto Tube Cleaners in service today, and are in a position to meet practically any demand to keep these machines working. We will make every effort to continue to service our equipment during the present emergency.

If you need parts or repair service on your old Roto, we are ready to serve you.

SEE OUR ADV. IN SWEET'S AND WRITE

The ROTO Company
145 SUSSEX AVENUE
NEWARK, N. J.



A Plus Service For Engineers

Backing up their regular advertisements in POWER PLANT ENGINEERING, many manufacturers have prepared special catalogs and bulletins describing in greater detail the construction, installation and operation of their equipment. This literature is up-to-the-minute and frequently contains engineering data not available elsewhere.

Should you desire a catalog or specific information regarding power plant equipment, we will gladly get it for you from the manufacturer. Let us know also if you are interested in any particular piece of equipment, such as a pump, compressor, motor, fan, superheater, and we will get useful data for you on the different makes. Just write our Reader Service Department.

Helpful Bulletins

BOILER PLANT EQUIPMENT

1 Boilers—"Engineering and Architectural Steel Boiler Data" is the title of a file folder picturing and describing in detail the various types of fire-tube and water-tube boilers built by Oil City Tank & Boiler Co.

2 Oil Burners—New 4-page folder just off the press, describes a line of wide range mechanical atomizing oil burners employing the Peabody patented constant differential valve system. Advantages include — extremely wide capacity range; increased fineness of atomization over the entire range because of higher oil pressures; simplified control. Peabody Engineering Co.

3 Boiler Tube Plug—Hardie Made-Rite Boiler Tube Plug Co. has issued a 14-page booklet indicating how boiler tube plugs are inserted to prevent shutdowns and loss of power. Types are provided for water-tube and fire-tube boilers.

4 Stokers—Canton Stoker Co. illustrated catalog describes Canton Lo-Set Ram Feed Stokers used for smaller installations where space is limited. Typical installations pictured.

5 Light Weight Refractory—4-page bulletin describes Plicast L-W-I, a new light-weight insulating castable refractory. This material is valuable for any application where refractoriness is required with high insulating efficiency. Recommended for service temperatures as high as 2200 deg. F. It is especially suitable for lining inspection doors of boiler furnaces, rear doors of fire-tube boilers, tube decks, ducts and breechings, water walls, etc. Plibrico Jointless Firebrick Co.

6 Coal Burners—Data gives facts in detail on the Fyr-feeder which incorporates features of adjustable feeder, multiple pneumatic spreader, and control of coal distribution. Burns cheapest coal sizes and reduces coal bills. American Coal Burner Co.

7 Integral Furnace Boilers — New well-illustrated Bulletin G-34 describes the B & W integral-furnace boiler as arranged for stoker firing and lower capacities. Contains sectional views and table of principal dimensions of this compact boiler which requires no structural steel work. The Babcock & Wilcox Co.

8 Rotor Stoker—Bulletin 832 gives complete pictorial description of Detroit Roto Stokers applicable to all types of boilers. Successfully handles all fuels including semi-anthracite, coke, breeze, low, medium and high volatile bituminous, sub-bituminous and lignite. Many photographs and drawings of Roto Stoker installations in varied industrial plants are shown. Detroit Stoker Co.

9 Coal Scales—Illustrated bulletin pictures butt-welded weigh hoppers, endless feeder belt and other outstanding construction features and operating advantages of Seco coal scales. Two models, 200 lb. and 400 lb., are shown. Stock Engineering Co.

10 Soot Blowers—Many installation photographs and blueprints of modern soot blower layouts are given in the 50-page Bulletin No. 884-A issued by Diamond Power Specialty Co. This soot blower handbook should be of interest to all engineers responsible for proper cleaning of boilers, economizers, etc.

a typical layout of 3-plane piping structure supported by hangers and eliminators. Types and characteristics of each presented.

56 **Tube Cleaners**—Free folder describes Airetool tube cleaners made for every tube condition in sizes from ½ in. to 20 in. I.D., air, steam or water driven. Airetool Mfg. Co.

57 **Desuperheaters**—Bulletins 5-21-D and 5-188-A describe Swartwout desuperheater for the safe, uniform control of steam temperatures. Design and application of carburetor, Venturi and atomizer types are described. The Swartwout Co.

PRIME MOVERS

58 **Steam Engines**—Two recent bulletins, "Modern Steam Engines" and "½ cent per Kilowatt hour power cost" deal with the flexibility, sustained overload capacity and economy of Troy-Engberg steam engines. Troy Engine & Machine Co.

59 **Diesel Engine**—Replete with illustrations and valuable information, Diesel booklet describes complete line of Cooper-Bessemer Diesels ranging in size from 50 to 1250 h.p. The Cooper-Bessemer Corp.

60 **Steam Turbines**—Eight page bulletin S-116 illustrates and describes application, construction, savings effected and advantages of the Terry solid wheel turbine. The Terry Steam Turbine Co.

61 **Packaged Diesels**—Folder issued by R. H. Sheppard Co. describes construction features and points out the many advantages of Sheppard "Packaged" Diesel units. These ready-to-run Diesels can be synchronized with main generators to cut costs on peak loads; or to drive pumps, compressors and other equipment.

62 **Turbine Generators** — A 78-page book describing General Electric's turbine-generators in ratings from 500 to 7500 kw. has just been published by the company. Designated GEA-3277-1, the new publication contains photos and charts which show the major steps in the manufacture of turbine-generator units. Sectional views of turbines, valve mechanisms, interconnecting mechanisms, generators, exciters and ventilation are given, as well as detailed sketches of various turbine types. Reference charts of turbine steam rates are also included.

WATER TREATMENT

63 **Water Treatment** — American Water Softener Co. 2-page folder deals with different types of mobile purification units made by company. Shows and describes model A, mounted on skids; Model B, mounted on trailer; and Model C, mounted on truck.

64 **Corrosion Prevention**—"Preventing Corrosion by Zero Oxygen" is the title of a 16-page bulletin discussing in detail the advantages of minimizing dissolved oxygen and other gases from boiler feed so as to reduce pitting and corrosion to boiler and auxuiliary surfaces and piping. Cochrane Corp.

65 **Boiler Water Treatment**—New illustrated folder, "Protect Your Boiler Investment," describes Dearborn services for feedwater test control, blowdown adjustment, automatic treatment application, etc. Helps point way to lower maintenance costs. Dearborn Chemical Co.

(Continued on page 136)

★ SPECIFY-ERNST ★

LEAKLESS COCKS

CAN BE ATTACHED TO ANY WATER COLUMN OR BOILER
ALIGNMENT AND STIFFENER ROD
NO GAGE GLASS PACKING NUTS
GLASS CAN BE SET AT ANY ANGLE OR VERTICAL

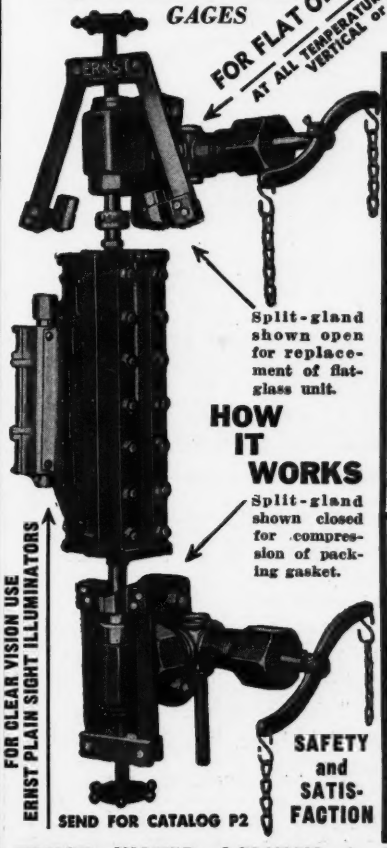
HAVE YOUR BOILERS EQUIPPED WITH

"SPLIT-GLAND"

ADJUSTABLE WATER GAGES

FOR FLAT OR ROUND GLASSES AT ALL TEMPERATURES AND PRESSURES VERTICAL or INCLINED

MADE TO FIT ANY WATER COLUMN OR BOILER



Split-gland shown open for replacement of flat-glass unit.

HOW IT WORKS

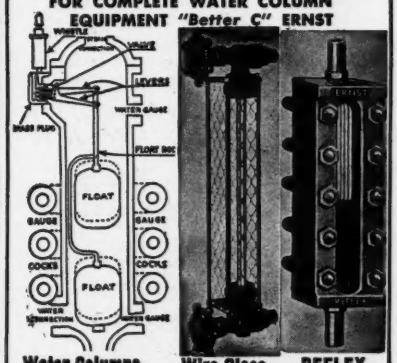
Split-gland shown closed for compression of packing gasket.

FOR CLEAR VISION USE ERNST PLAIN SIGHT ILLUMINATORS

SEND FOR CATALOG P2

SAFETY and SATISFACTION

FOR COMPLETE WATER COLUMN EQUIPMENT "Better C" ERNST



Water Columns Forged Steel For All Pressures

Wire Glass "Better C" Guards

REFLEX "C-Black" Glass Inserts

High pressure and temperature Gage Glass Gaskets—"They Won't Blow Out."

ROUND • TUBULAR GLASSES for High Pressure Service — Clear or Red Line Magnifying.

CLEAR & REFLEX GLASSES, all sizes

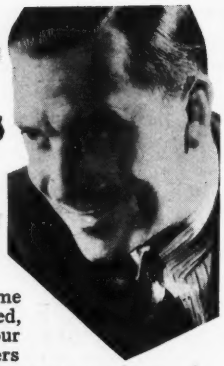
ERNST WATER COLUMN & GAGE CO., LIVINGSTON, N. J.

DISTRICT OFFICES: NEW YORK • INDIANAPOLIS • CHICAGO • LOUISVILLE • PITTSBURGH DENVER • TULSA • HOUSTON • DETROIT • CLEVELAND • LOS ANGELES

Change of Address

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

How We "Sunk" Our Water-logged Float Worries



"THERE was a time when weak-kneed, water-logged floats in our tanks, feed water heaters and liquid level controls gave us plenty of headaches. But we sunk these worries for good when we installed Nicholson Welded Floats."

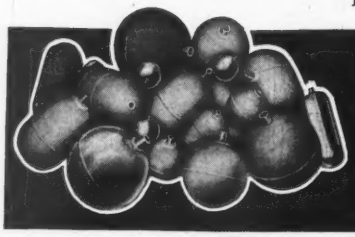
You, too, can end the bother and expense of float replacements by specifying Nicholson Floats. They are die formed—not spun or laminated—with the welding seam serving as a reinforcing ring. This extra sturdy construction enables Nicholsons to stand hydrostatic pressures up to 2500 lb.

Available in sizes 2 in. to 14 in. diameter, in special, elliptical or cylindrical shapes, in stainless and chromium plated steel. Also with cadmium, nickel or copper plating. Complete data in Bulletin 339.

Also Nicholson

Steam Traps
Flexible Couplings
Steam Separators
Control Valves
Compressed Air Traps
Expanding Mandrels
Arbor Presses

W. H. NICHOLSON & CO.
160 Oregon St., Wilkes-Barre, Pa.



NICHOLSON *Welded* **FLOATS**

WE READ WATER

Every drop of water and every drop of brine has a story to tell us. We know how to read it and answer the many difficulties it is bringing your plant. The story tells a battle against efficiency in your plant . . . corrosion, scaling, living organisms, too much of this chemical, too little of that. We read it, tell the answer, and have the organic chemicals to correct the water and the brine. Known throughout the Nation are these Haering products . . .

Chrom Glucosates
For Corrosion Prevention

Sodium Glucosate
For pH Adjustment

Sulpho Glucosate
For Oxygen Removal

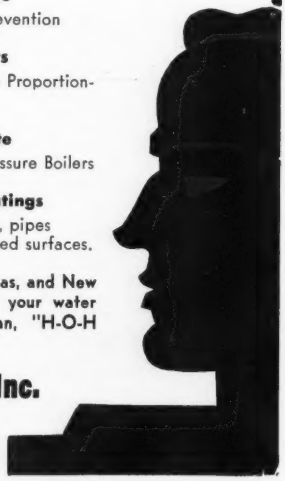
Quachrom Glucosate
For Corrosion Control

Beta Glucoside
For Scale Prevention

H-O-H Feeders
For Accurate Proportioning

Pyro Glucosate
For High Pressure Boilers

In-Hib-Co Coatings
Protect tanks, pipes and all exposed surfaces.



Our laboratories in Chicago, Wichita, Kansas, and New York City serve you overnight. Send us your water problems; or write for our house organ, "H-O-H LIGHTHOUSE."

D. W. HAERING & CO., Inc.
Water and Brine Consultants
General Offices
1800 Engineering Bldg., 205 West Wacker Drive Chicago

66 Chemical Feeders — Nine-page Bulletin No. 122 illustrates and describes Proportioneers chemical treating and feeding systems for power plants. It includes the handling of phosphates, sulphites, sulphates, sulphuric acid, etc. A valuable reference bulletin for engineers on problems of scale, pitting and corrosion, carry-over. Proportioneers, Inc.

67 PH and Chlorine Control—"Modern pH and Chlorine Control" is the title of a valuable new 80-page handbook for plant engineers. It describes Taylor pH and chlorine control equipment; also Taylor water analyzer for determinations such as silica, iron and direct nesslerization of ammonia. W. A. Taylor & Co.

68 Boiler Water Treatment — "50 Years of Notable Contributions to Scientific Boiler Water Treatments" is the title of a useful handbook on types of waters, operating situations, types of treatments. The Bird-Archer Co.

69 Water Testing — A revised edition of their Testing Equipment catalog has recently been issued by the National Aluminate Corp. The Nalco Colorimetric Kit has been redesigned with several advantages over its predecessor. A new item is the Nalco Pressure Filter for speeding up the filtration of water samples.

MISCELLANEOUS

70 Oil Maintenance — "Continuous Maintenance of Lube Oil" by Walter C. Bauer, M.E., is the title of a 10-page bulletin issued by The Briggs Clarifier Co. This helpful bulletin charts and describes the performance of various lubricating oils before and after clarifiers were used.

71 Instant Steam Water Heater—Bulletin describes the many applications of an instantaneous steam water heater built for heavy duty service; may be used as external heater, pre-heater, after-heater and for other purposes. The Johnson Corp.

72 Diesel Noise Control—Data book describes design, application, as well as accomplishments of Burgess exhaust snubbers for reducing noise nuisance in Diesel exhaust without increasing fuel consumption. Burgess Battery Co.

73 Maintenance Suggestions—A 50-page illustrated handbook, "Over the Rough Spots," describes the application of Stonhard materials for smoothing rutted floors, broken driveways, leaky roofs; also suggests methods for waterproofing and acid-proofing building walls, vats, tunnels, etc. Stonhard Co.

74 Metal Packing — Described in Catalog M-5 are the design and performance features of France full-floating metal packings for sealing piston rods in any type of reciprocating engine, pump or compressor. The France Packing Co.

75 High Temperature Coatings — Bulletin 950, covers Preferred White Hot. a high temperature coating and heat reflecting agent for maximum temperatures of 2840 deg. F. and which will adhere to such surfaces as refractories. ceramics, glass, metals, exhaust pipes of internal combustion engines, high temperature stacks, breechings, steam lines, etc.. Preferred Utilities Mfg. Corp.

(Continued on page 138)

All Taylor Forge Fittings are critically inspected for circularity of ends, accuracy of dimensions, and smoothness of inside wall.
6" STD. TAYLOR FORGE WELDELL PAT. 1936805

An extra operation for us provides extra value for you in WeldELLS

ONE of the big reasons practical men prefer WeldELLS is because these *engineered* fittings line up so perfectly. And the reason WeldELLS do line up so precisely, so easily, is because every one is given a *truing operation* to bring the fitting to *exact* size before machining bevel and land. Incidentally that's also why both bevel and land are so accurate and uniform in WeldELLS.

Of course it costs us something to perform this operation—and we could "get by" without it. But we believe that the extra value provided fully justifies the expense.

So here again the Taylor Forge principles of sound engineering design, maximum simplicity, utility and economy, bring added value to users of welding fittings.

And remember that with all their extra value features Taylor Forge Fittings cost no more than other makes.

• You'll find the complete story in our big Catalog 401—216 pages of usable information and valuable engineering data. Write for it today.

TAYLOR FORGE & PIPE WORKS

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OTHER EXTRA VALUE FEATURES

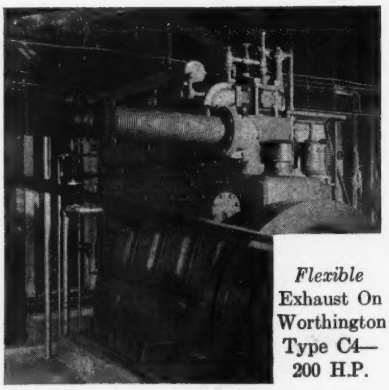
In addition to the features described opposite, WeldELLS have the following advantages which are combined in no other welding fitting:

1. **Seamless**—greater strength and uniformity.
2. **Tangents**—keep weld away from zone of highest stress—simplify lining up.
3. **Precision quarter-marked ends**—simplify layout and help insure accuracy.
4. **Permanent and complete identification marking***—saves time and eliminates errors in shop and field.
5. **Selective reinforcement**—provides uniform strength.
6. **Wall Thickness never less than specification minimum**—assures full strength and long life.
7. **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
8. **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

*Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.

PENFLEX Exhaust Pipes

Plain *or* Air Jacketed
Sizes 1″ to 18″



Flexible Exhaust On Worthington Type C4—200 H.P.

How to *Stop* "Exhaust Whip"

Being at right angles to the main plane of engine vibration makes it "just too bad" for horizontal exhaust runs. Put in a section of *flexible* all-metal tubing . . . as shown above. No matter how relations change between manifold outlet and muffler inlet, PENFLEX 4-wall interlocking joint construction kills strains before they can start.

Takes Care of Expansion Also

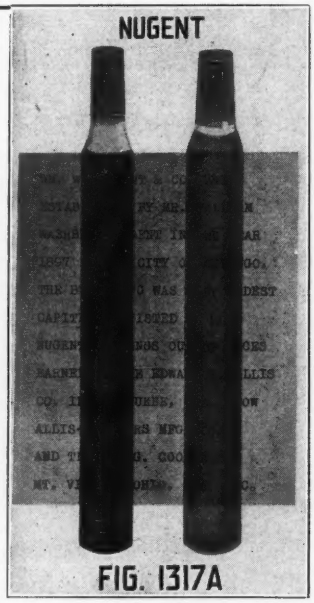
With ⅜″ of "come and go" for every running foot, thermal changes simply have no effect at all. Long runs of solid-wall pipe are adequately served by short lengths of PENFLEX. In crowded quarters, our exclusive flexible air jacketing provides added safety for personnel. Either type bends to fit the installation without heat or special tools.

Get the many good Diesel exhaust ideas in Bulletin 70

Pennsylvania Flexible Metallic Tubing Co.
7207 Powers Lane, Philadelphia, Pa.

Here's the way Crankcase Oil Looks BEFORE and AFTER it is Filtered through a

NUGENT FILTER!



(Actual unretouched photograph)

- ***BEFORE:*** Shown at the left is a sample of dirty crankcase oil taken from a 300 H.P. gas engine *before* installing Nugent Filter.
- ***AFTER:*** At the right is a sample of oil from the same engine *after* installing Nugent Filter, and operating 1,344 hours before cleaning filter.

Wm. W. Nugent & Co., Inc.
Established 1897
423 N. Hermitage Ave., Chicago

Mail Coupon for Data

Wm. W. Nugent & Co., Inc.
423 N. Hermitage Ave., Chicago, Ill.
Please send me literature and information about the following Nugent specialties: ☐ Diesel Engine Fuel Oil Filters. ☐ Diesel Engine Lube Oil Filters. ☐ Turbine Oil Filters. ☐ Sight Feed Bearing Oilers. ☐ Telescopic Crank Pin, Crosshead Pin and Eccentric Oilers.

Name .....
Company .....
Address .....

76 Repair Guide — How to make practical and lasting repairs to equipment and pipe lines without dismantling or use of heat, is described in a revised edition of the Smooth-On Handbook. 40 pp. with 170 diagrams and simple instructions make a helpful repair guide for engineers, mechanics, and maintenance men. Smooth-On Mfg. Co.

77 Oiling Devices—Catalog describes a complete line of oiling devices, oiling and filtering systems, telescopic oilers, sight feed valves, flow indicators, compression union fittings, oil pumps, etc. Wm. W. Nugent & Co. Inc.

78 Air Scrubber—New Bulletin No. 689 gives application and operating data on W-K-M Master air scrubbers. These scrubbers remove moisture and dirt, help increase efficiency of control boards, riveting hammers and other air-operated equipment. Bradshaw & Co.

79 Building Maintenance — Handbook of 74 pages of technical information for plant managers, maintenance men and superintendents. Shows how to do hundreds of odd jobs at lower cost with better results. Presents many ideas that save valuable time and materials. Over 150 pictures, diagrams, mechanical drawings. Flexrock Co.

80 Diesel Maintenance — 20-page booklet describes Oakite methods for removal of hard water scales, rust and similar deposits from Diesel water jackets, cooling systems, water cooled compressors and other power service equipment. More than 15,000 engineers and executives have requested this helpful maintenance book. Oakite Products, Inc.

81 Conveyors — Illustrated Bulletin 109 contains many illustrations of Robins belt conveyors, belt trainers, bucket elevators, coal crushers, weigh larries, and other equipment for the economical handling of coal, coke, ashes, sand, chemicals and other bulk materials. Robins Conveying Belt Co.

82 Insulating Data Chart—Engineering Data and Property Chart No. 416 should be helpful to electrical and chemical engineers and others concerned with use of insulating parts for electrical, oil and gas equipment. American Lava Corp.

83 Flooring Handbook—"New Ideas in Functional Floor Design" is the title of a 16-page handbook on the many uses of open steel floor grating just published by the Open Steel Flooring Institute. Included are a Table of Safe Loads—a typical hypothetical floor layout—detailed clipping or fastening diagrams— suggested specifications.

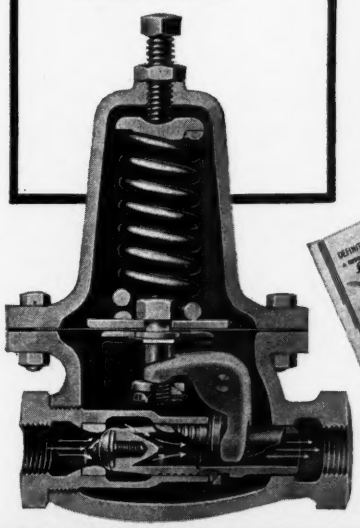
84 Anti-Vibration Mountings — The B. F. Goodrich Co. has just published a new 12-page catalog on its Vibro-Insulators, the devices of metal and rubber which combat vibration and noise problem in power houses and manufacturing plants. Applications of the mountings on motors, air compressors and various types of equipment are listed.

85 Conveyor Book—No. 1975—24-page illustrated catalog and data book by Link-Belt Co., discribes Bulk-Flo—a new power-operated conveyor system for continuous conveying of flowable granular, crushed, ground or pulverized materials. Shows several power plant coal handling installations.

Check

EVERY ONE OF THESE VALVE *Benefits* IN YOUR OWN PLANT . . .

- maximum capacity when needed most
- accurate pressure control under toughest working conditions
- trouble-free service
- smooth operation
- tight closure
- accurate regulation
- speedier production results
- elimination of failures
- constant delivery pressure
- cost saving operation
- no service attention
- no spoilage
- practically zero in maintenance costs



CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVE

It costs you nothing to check up on these benefits

Put a CASH STANDARD Streamlined Type 1000 Valve to the test for 30 days — you can do it FREE — find out what its performance means in dollars and cents savings — see how flow, that is not broken up by valve stems, springs, or other parts, adds immeasurably to better all around results — after 30 days a bill is sent to you — you either pay the bill or return the valve to us at our expense. Putting this test off may be losing valve money for you.

NONE OF THIS TURBULENCE

GIVES THIS FLOW PATTERN

If you want full details on the STREAMLINED "1000" *Valve, send for bulletin 1000.*

This bulletin gives you complete design and operating facts. Steam, air, and water capacity charts are shown —they enable you to determine precisely how much fluid any size Streamlined Valve will deliver under your exact pressure conditions—for steam, air (and other gases), water (and other liquids).

Straight Line Flow

FROM INLET TO OUTLET

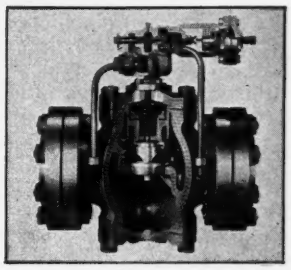
A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

A CASH STANDARD "GET ACQUAINTED" COLUMN

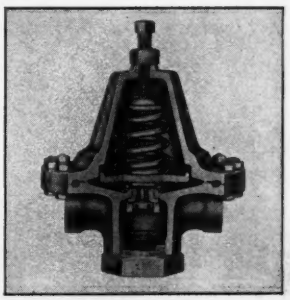
Question: "Don't you people make anything besides that Streamlined Valve you talk about so much?"

Answer: "Yes Sir; we do! And we propose to picture one or two of them here each time."



Cash Standard Type 11 Regulator, for use with water, air or any gas or oil that is non-corrosive. Pressure to actuate pilot valve may come from any source; and be as high as 1500 lbs. Variety of uses, notably as condenser water regulator.

Inlet pressure up to 600 lbs.; outlet pressure up to 250 lbs. Bodies; iron, bronze, steel. Trims; iron, bronze, stainless steel. Screwed, flanged, or ammonia type ends. Sizes: 2" to 12".



Cash Standard Type 8871 Pressure Reducing Valve; for use with liquids — especially dirty liquids, like Bunker C fuel oil for example. No sliding fits: inner valve bolted to diaphragm for positive movement.

Initial pressure up to 250 lbs., reduced pressure up to 200 lbs. Bodies; iron, bronze or steel. Renewable inner valve and seat ring, stainless steel. Sizes: ½", ¾", 1".

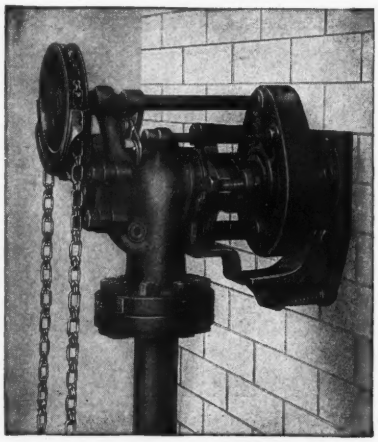
Get Free Bulletins on Above . . . Write to
A. W. CASH COMPANY
DECATUR, ILL.

Something NO BOILER Should be Without!

Unattended to or poorly attended to, soot accumulations can rob boilers of as much as 25% of their efficiency, causing huge wastes in fuel.

Learn how inexpensively you can install Vulcan Soot Blowers to thoroughly and easily clean your boilers at regular intervals. They are constructed to stand up under severe high temperatures, to perform efficiently with minimum maintenance cost and minimum installation and operating trouble.

The list of well-known industrial and utility plants using Vulcan Blowers is itself an infallible testimonial to their outstanding performance and their investment value.



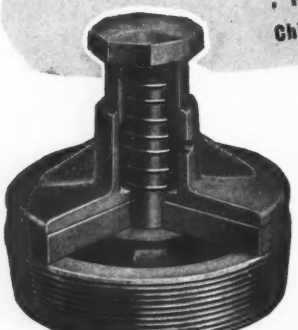
Write Today for Information

VULCAN SOOT BLOWERS

VULCAN SOOT BLOWER CORP. — DUBOIS, PENN.

How 1 Pump Valve Job Brought 11 More Orders

. . . experience of big Chicago implement plant



A LARGE farm implement plant in Chicago had a lot of maintenance trouble with two hydraulic elevator pumps. Almost each Saturday their engineer had to take down the pumps and replace broken valve springs and snapped-off studs. The pumps were steam wasters, too.

Several years ago they tried out one pair of COMBINATION Pump Valves on one of these hard-to-maintain pumps. When these non-tilting valves were examined after six months' operation, the engineer said they were as good as new. As a result of their notably satisfactory service COMBINATION Pump Valves were ordered for eleven other pumps at this and other plants of the implement manufacturer.

Many users say the power and replacement savings of COMBINATION Pump Valves repay their cost in six months' time. They match the satisfaction delivered by COMBINATION Silent Check Valves. Why not give them a chance to prove their superior performance and economy on your pumps? Write for descriptive folder and details of our Free Trial Pump Valve Offer. Mail the coupon

For Boiler Feed, Vacuum, Condenser, General Service Pumps

Coupon Brings Descriptive Bulletin and Details of FREE Trial Offer.

COMBINATION PUMP VALVE CO.

846 Wiota Street **Philadelphia, Pa.**

Without obligation, please send me full details about your Trial offer on COMBINATION Pump Valves.

Name .....

Company .....

Address .....

MAIL COUPON TODAY

Water Treatment. By G. V. James. Published by the Chemical Publishing Co., Inc., Brooklyn, N. Y., 1941. Copyright in Great Britain by The Technical Press Ltd., London. 135 pp., 6 by 9 in., hard bound cloth cover. Price $12.00.

Water is so universally used by man that its treatment is of vital concern to everybody and the author, a British scientist, has presented up-to-date information on the general treatment of water for domestic and industrial uses. The book was prepared to be useful to chemists, engineers, and sanitary authorities but others will find it interesting reading as it is remarkably free of technical terms and presents information everybody should know about water he drinks and uses in industrial processes. In the introductory chapter the reader is given an idea of the treatment of the subject as it is followed out through the book. Sections of this chapter deal with the storage and self-purification of natural waters, sedimentation and coagulation, the use of iron and aluminum and other compounds in clarification, and filtration methods and means. In a similar manner other chapters in Part I deal with sterilization, removal of color, odor and tastes, prevention of action on metals, water softening, army use of water, purification for swimming pools, and feedwater treatment. Part II, consisting of four chapters, deals with industrial supplies and effluents, and the three chapters in Part III treat subjects having to do with domestic sewage.

Effects of Bonding Exchange Aerial Telephone Cable Sheaths to Multiground Power Neutrals. Engineering Report No. 43. Published by the Edison Electric Institute, 420 Lexington Ave., New York, N. Y., 1941. Price 30c. to E.E.I. members and their employes, 75c. to non-members in U. S. A., 85c. to foreign countries including mailing charges.

This is a report of a joint subcommittee on development and research of the Edison Electric Institute and the Bell Telephone System. Results are given of an investigation of the shielding benefits derived by bonding the sheaths of aerial exchange telephone cables to multi-grounded power system neutrals. The theoretical discussion is supported by data from an extensive survey of the effects of sheath-neutral bonding on noise.

Preservation of Business Records. By Ralph M. Hower. Published by The Business Historical Society, Inc., Soldiers Field, Boston, Mass. Size 6 by 9 in., 56 pp., paper cover. Free on application.

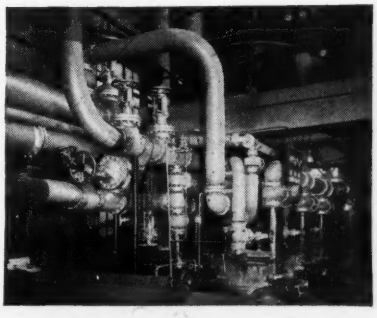
First published in 1937, it is now revised for a fourth printing and gives answers to: Why should business records be preserved; what material should be preserved; how should records be preserved; when should preservation be undertaken. Purposes of records in bettering public relations, keeping track of effectiveness, knowing what a business is doing are analyzed. What not to keep and when and how to destroy temporary records are also treated. Examples of practices in various lines of industry are cited, including advertising agencies, public utilities and manufacturing organizations.

The Man in the Power House . . .

A nation bent on conquest built a war machine. The like of it was never seen before. It gobbled up in a single year of building, *100 billion* kilowatt hours of Power.

Then America went to work. Even before Defense Production hit its stride, the Power demanded by American Industry reached *145 billion* kilowatt hours!

And the Man in the Power House was ready.



For years he had been quietly boosting production. He had raised steam pressures from 300 pounds in 1920 to 500 . . . 800 . . . 1000 . . . 1200 pounds by 1938! He had built new boilers ten times as powerful as 1920 models of the same size.

He now made a pound of coal produce *four times* the power it did before!

In this great and continuing Progress of Power, INCO Nickel Alloys play an important part. Strong, tough, hard, and resistant to heat, corrosion and erosion, Monel, "K" Monel, "S" Monel and the rest of them have proved well able to withstand the stepped up tempo. In the Power industry and scores of others these metals are contributing to Production for the Emergency.

• • •

With steam temperatures in modern power plants up to red heat, and pressures six and eight times what they were in 1920, INCO nickel alloys are serving for valve trim, springs, pump rods and impellers and many other vital parts.

This advertisement featuring the progress of the Power Industry appeared in the August 9th issue of "Business Week" and the August 18th issue of "Time".

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York, N. Y.

MONEL "K" MONEL "S" MONEL "R" MONEL NICKEL "Z" NICKEL INCONEL

Gives QUICK Answers to ALL Flow Questions

HOW much water is going into steam? . . . Are boilers working at top efficiency? . . . How much gas are we using each day? . . . Let a Simplex Meter give you the quick, accurate answers to these important plant flow questions.

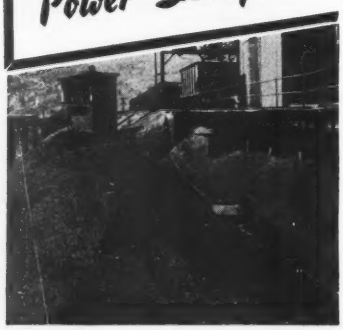
Simplex Meters can be used with any type of pressure producing device (orifice, nozzle, venturi tube) in any size of main to totalize the flow of Boiler Feed Condensate, Steam, Air, Gases and Corrosive Liquors. It is extremely accurate and reliable over wide ranges. And its modern price puts it within easy reach of every plant. Write for new descriptive bulletin.

TYPE MS METER

SIMPLEX VALVE & METER CO., 6790 Upland St., Philadelphia, Pa.

SIMPLEX METERS

SAUERMAN
Power Scrapers



● For dependable, economical coal storage, a Sauerman Power Drag Scraper with its definite operating advantages, versatility and flexibility, is your best investment. Low initial cost, simplicity of installation and operation, coupled with better handling (coal is stored in layers—eliminating air pockets and hot spots) make the Sauerman system of coal handling the logical method for those who want the best.

Write for Catalog, data sheets.

SAUERMAN BROS., INC.

486 Clinton Street Chicago, Illinois

How Advertising Speeds Progress

Besides raising our standards of living, good advertising greatly shortens the time between invention and utilization, which speeds the progress of new industries, helps make men and machinery more productive.

Interior Electric Wiring and Estimating. By Albert Uhl, Arthur L. Nelson and Carl H. Dunlap. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Third Edition. Size 5½ by 8½ in.; 350 pp.; cloth bound. Price $2.50.

While retaining the general arrangement of the earlier editions, the book has been extensively revised and enlarged, primarily to bring it in accordance with the newest National Electrical Code adopted late in 1940. It is divided into 8 general sections covering: service wiring; knob and tube wiring; cable wiring; conduit wiring materials, tools and methods; apartment building wiring; factory wiring; and a 50 pp. chapter on estimating.

Formerly ratings were given on 3 kinds of insulation for electric wires, but the new Code gives ratings for 17. The current-carrying capacities of wires using these different insulations and the different conditions under which each type is to be used have been included. Over 50 pp. of new material have been added, and, in addition, all the illustrative problems have been gone over and revised to comply with the new Code.

The whole book is written in a practical "how-to-do-it" manner and a new section on cable wiring includes the wiring and installation of outlets in old houses in which wiring was never installed. New drawings have been prepared to show the construction of houses, how floor boards can be removed, how the floor joists are bored, how old plaster can be held in place when cutting an outlet opening, etc. Sections on factory wiring for both light and power circuits are equally practical and complete.

Engineering Encyclopedia. Two volumes, 6 by 9 in. 1431 pp.; 206 illustrations; hard cloth binding. Published by the Industrial Press, 148 Lafayette St., New York City. Price $8.

At last there is available a set of books that gives the practicing engineer concise information in language of the engineering profession on nearly every subject pertaining to various branches of engineering. It might well be called an interpreter of scientific and trade terms but it is decidedly more than that for it gives comprehensive information on each term without going into needless details. In other words the Engineering Encyclopedia supplies, in condensed form, the essential facts about 4500 standard and special engineering subjects. Although intended primarily for reference purposes, it will be helpful to those seeking knowledge relating to the outstanding subjects in many different branches of engineering. This Encyclopedia consists of concise treatises ranging from short paragraphs to several pages in length. These deal with various important mechanical laws, rules and principles; physical properties and compositions of a large variety of materials used in engineering practice; the characteristic features and functions of different types of machine tools and other classes of manufacturing equipment; and many other subjects related to engineering. These condensed treatises are accompanied by definitions of numerous trade and technical terms. All matter is arranged alphabetically, with liberal cross references.

An aid to greater plant safety
described in the new Kennedy Catalog

Some of the KENNEDY Valve Types

Standard Bronze rising stem gate valve

200-lb. Bronze non-rising stem gate valve

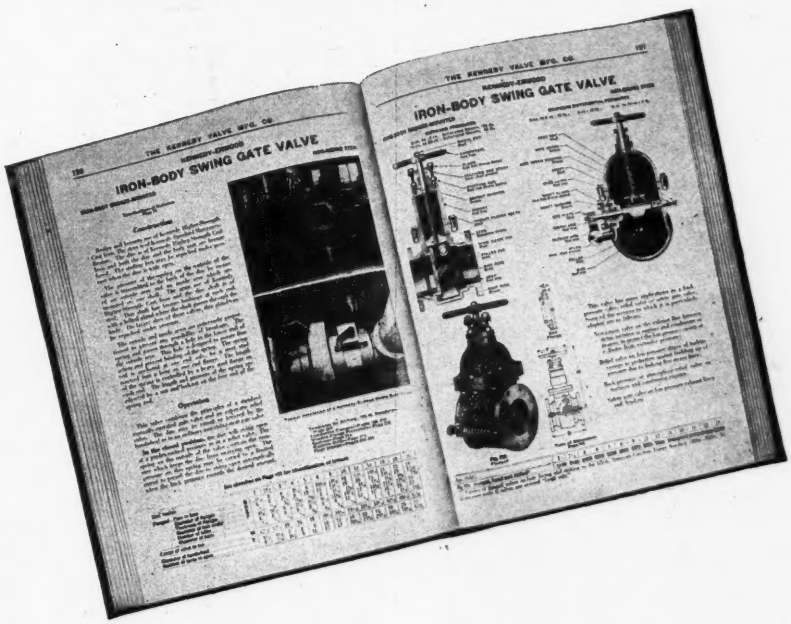
Low-pressure iron-body non-rising stem flanged valve

Standard iron-body outside-screw-and-yoke flanged valve

175-lb. Iron-body non-rising stem screwed valve

250-lb. Iron-body outside-screw and yoke flanged valve

Small electrically-operated valve

Cylinder-operated valve

The ingenious safety feature of the Kennedy-Erwood Valve is the spring-controlled disc, which enables the valve to be closed as a standard gate valve, but which opens automatically at a predetermined back pressure to relieve excessive unbalanced pressure. This design therefore combines the functions of a gate valve, check valve and relief valve in a single unit. It has proven its benefits in service as a non-return valve, back-pressure valve, atmospheric relief valve, and safety gate valve, wherever low-pressure apparatus should be protected against building up of excessive pressures.

The design and features of the Kennedy-Erwood Valve are fully explained in the new 240-page Kennedy catalog, which also includes bronze and iron body gate, globe, angle and check valves for a wide range of pressures, bronze and malleable iron screwed pipe fittings, and cast iron flanged fittings. Every valve user should have a copy of this helpful catalog.

The Kennedy Valve Mfg. Co. . . . Elmira, N. Y.

Send the coupon for your copy

The Kennedy Valve Mfg. Co., 2013 E. Water St., Elmira, N. Y.
Please send copy of your new 240-page catalog.

Name .....

Position .....

Company .....

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KENNEDY

Extra Values in VALVES and PIPE FITTINGS

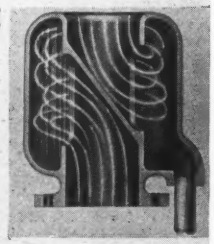
In more than
12,000 Plants
COCHRANE
MULTIPORT
RELIEF VALVE

Cochrane Multiport Back Pressure Relief Valve with front and back plates removed.

Successful operation of the Cochrane Multiport Valve in more than 12,000 plants is a sure guarantee of its continuously reliable operation. This continuous operation is insured by the multiport principle — a number of small discs instead of one large disc, eliminating the sticking, jamming and freezing common to single-disc valves in the control of atmospheric relief, back pressure, etc.

Call your Cochrane representative or write for further details.

COCHRANE Exhaust Head



Designed to separate condensate and oil from steam discharged to atmosphere and thereby prevent raining of water and oily condensate on the roof, Cochrane Exhaust Heads incorporate a highly efficient free-flowing baffle type construction and an exceptionally large port area which minimizes back pressure. Write for further details.

COCHRANE CORPORATION
3123 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me complete information on Cochrane Multiport Relief Valve and Cochrane Exhaust Head.
Name_____
Firm_____
Address_____
City_____ State_____

The Guntersville Project. Published as T.V.A. Technical Report No. 4. For sale by the Tennessee Valley Authority, Treasurer's Office, Knoxville, Tenn. Size 6 by 9 in., 409 pp., cloth bound. Price $1.00.

This is a comprehensive report on the planning, design, construction and initial operation of the Guntersville Project of the T.V.A., one of the nine main river projects of the Tennessee Valley Development. Six of these have already been completed and are covered by the following reports: No. 1, The Norris Project; No. 2, The Wheeler Project; No. 3, The Pickwick Landing Project (see p. 138, July issue); No. 4, The Guntersville Project (covered by this review); No. 5, The Hiwassee Project (in preparation); and No. 6, The Chickamauga Project (in preparation).

Like its companion reports, No. 4 is well illustrated, logically arranged and covers in considerable detail various steps in engineering and design from inception to completion and initial operation. Chapter 9 gives a complete breakdown of costs and various appendices give statistical summaries, consultants' reports, special tests and model studies. Technical Monograph No. 48, published separately for $2.50, contains 105 selected drawings of the project. These separate sets of drawings are or will be available for all of the reports.

Flight—Construction and Maintenance. By Bailey Wright, W. E. Dyer and Rex Martin. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 6 by 9 in., 251 pp., cloth bound in two colors. Price $2.50.

In this day and age with the airplane playing such an important part in world affairs, everyone has at least a casual interest in aeronautics, and, no doubt within the next 2 or 3 yr. many mechanics and young men now in the power field will find themselves in this rapidly expanding industry.

We consider this sufficient justification for reviewing a book somewhat out of our field. Quite aside from this, however, the book is exceptional and will prove useful to anyone who has occasion to design, fabricate or maintain machinery.

The chapter on blueprint reading is one of the best short monographs on this subject which has appeared, while the chapters on woods, metallurgy, welding and repair will be of value to engineers in any line of activity. Chapters on airplane construction, rigging and the propeller are, of course, more specific, although even in these the methods developed to give great strength with little weight may well be adapted to other lines.

Captain Wright is with the C.A.A. in Chicago and Mr. Dyer is instructor in charge of Mechanics, Lewis School of Aeronautics, Lockport, Ill. Flight—First Principles is a companion volume covering the history of aviation, theory of flight, gliders, parachutes, etc. The authors are Captain Wright, and James J. Smiley and Rex Martin. This book in the same size and binding also sells for $2.50. The two books together give a remarkably clear picture of all phases of aviation, for those interested in the subject casually because of the current importance of the airplane, or, for those with a specific interest in the industry as a prospective employer.

Opportunities Offered

SALES REPRESENTATIVES wanted in several locations to fill out the sales organization of an old line manufacturer now offering one of the most successful spreader stokers available for small and medium sized boilers. This is a real opportunity for an aggressive salesman to tie in with a nationally advertised product that is rapidly superseding many of the older methods of firing. Give full particulars regarding your present accounts, experience, etc. Confidential. Address John R. Armstrong, Room 2100, 205 W. Wacker Drive, Chicago.

Help Wanted

ASST. OPERATING ENGINEER, industrial power plant small Illinois town. Steam-electric operating experience necessary. Capable of studies to improve efficiency. Chain stokers, water tube boilers, 1500 KW turbo-generator, cooling tower. Address Box 1217, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Graduate Mechanical Engineers, preferably under 40, with practical experience in boiler-room operation and knowledge of combustion problems. No applications considered unless accompanied with complete history of applicant's background and experience. Box 1212 Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Mechanical Engineering graduates not over 40 for design and assembly layout of boilers and accessory equipment. Knowledge of descriptive geometry and thermodynamic calculations very helpful. Location, Middle West and East. Applications must include full resume of schooling, firms worked for and details of experience. Box 1213 Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

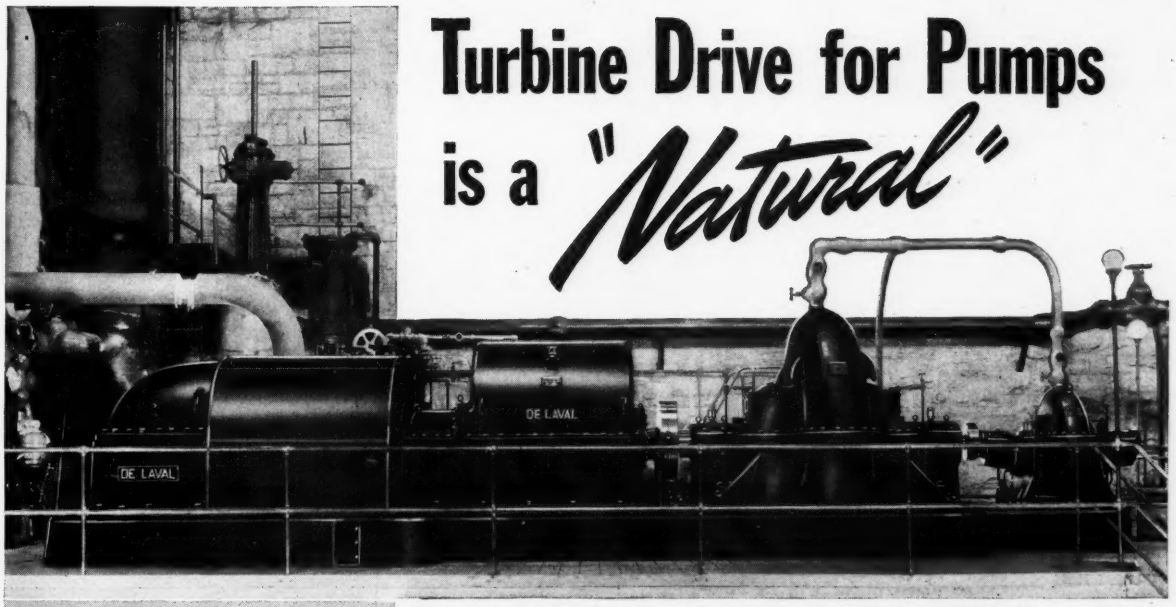
Equipment Wanted

Wanted: Used Engine Generator Set; 125 K.W.-D.C. 220-240, direct connect. Uniflow preferred. Must be in good condition. Campbell Laundry Company, 714 W. Michigan St., Milwaukee, Wis.

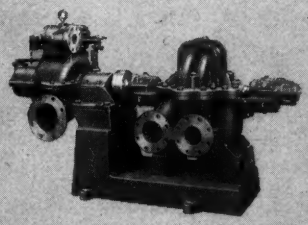
Reliable Buying Bulletins

In these pages you will find advertisements of firms that make every type of machinery and equipment for generating, distributing and utilizing power. Their messages constantly record latest progress in power plant equipment. They tell you who makes it, who stands behind it. Consider their advertisements as convenient and reliable buying bulletins.

Turbine Drive for Pumps is a "Natural"



Geared pressure-stage turbine driving water works pump; 80 m.g.d. against 187 ft. head, using steam at 175 psi. and 533°F. This unit developed a duty of 222.8 million foot pounds per 1,000 lb. of steam, as corrected to contract conditions.



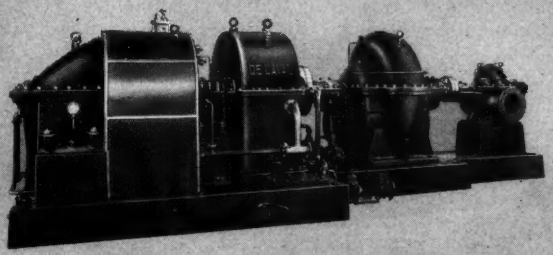
Velocity-stage turbine driving boiler-feed pump; 1,000 g.p.m. against 807 ft. head at 3,500 r.p.m.

THE speed of steam turbine driven pumps can readily be controlled, either automatically or manually, to supply just the desired head and flow, thereby avoiding the great waste of power incurred in throttling motor-driven pumps to meet head and flow requirements.

Large centrifugal pumps driven through speed reducing gears by De Laval multistage condensing turbines develop high duties, and are free from the transmission charges, losses and interruptions of service inseparable from motor drives.

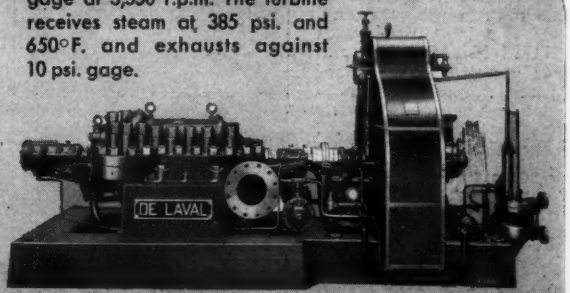
De Laval velocity-staged turbines exhausting to feed heaters or to process show similarly high economies and are most sturdy and reliable drives for power plant or process pumps.

State your conditions and ask for Publication T-3525.



Geared pressure-stage turbine driving main pump of 20,000 g.p.m. capacity against 148 ft. head and condenser circulating pump of 1,300 g.p.m. against 60 ft. head.

Velocity-stage turbine driving six-stage boiler feeder; 850 g.p.m. of 220°F. water against 1,600 psi. gage at 3,550 r.p.m. The turbine receives steam at 385 psi. and 650°F. and exhausts against 10 psi. gage.



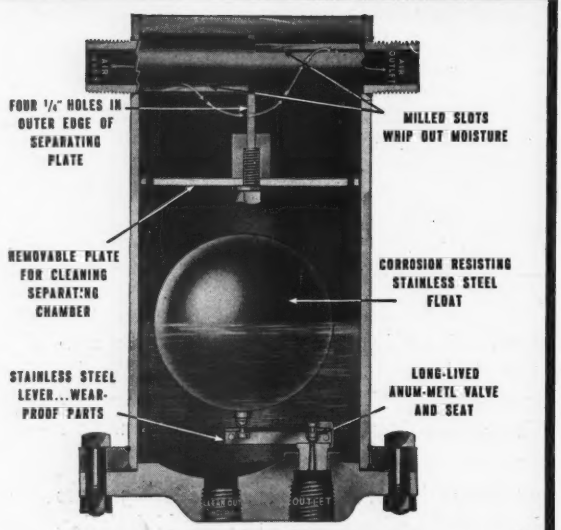
DE LAVAL Steam Turbine Co.

TRENTON, N. J.

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC, PUMPS . . . CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING, CENTRIFUGAL BLOWERS and COMPRESSORS, GEARS . . . WORM, HELICAL and FLEXIBLE COUPLINGS

PIPEWRENCH PETE SAYS:

USE THIS 2-in-1 TRAP AND SEPARATOR ON AIR AND STEAM LINES


FOUR 1/4" HOLES IN OUTER EDGE OF SEPARATING PLATE
MILLED SLOTS WHIP OUT MOISTURE
REMOVABLE PLATE FOR CLEANING SEPARATING CHAMBER
CORROSION RESISTING STAINLESS STEEL FLOAT
STAINLESS STEEL LEVER...WEAR-PROOF PARTS
LONG-LIVED ANUM-METL VALVE AND SEAT

STRONG COMBINED SEPARATOR AND TRAP

IF IT'S *DRY* AIR OR STEAM YOU WANT--

This STRONG 400 series combined separator and trap does two jobs in one to give you dry air or steam for after-coolers, sand blasting machines, anywhere!

STRONG'S complete line of specialties will lick problems you run into every day. Traps that don't dribble, with ANUM-METL seats and discs guaranteed leak-proof a year . . . practically indestructible valves . . . engine stops that can't fail . . . plenty of others.

Learn about STRONG products that can improve production and cut costs for you. See the catalog list on the right.

VALUABLE NEWS IN EVERY ONE!

CATALOG 63-PE7—Steam traps—open and inverted bucket. Drainage systems. Easy way to size traps.

CATALOG 252-PE7—Mechanical and electrical engine stops. Boiler non-return valves.

CATALOG 227-PE7—Separators for steam, oil, gas or gasoline. Money-back guarantee!

CATALOG 154-PE7 — Pressure regulating valves, pump governors and strainers. Tables for sizing regulating valves.

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The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

Protecting Fuse Tubes Against Insects

INSECT NESTS of bees, wasps and the like in the fuse tubes of cutouts may plug the bore, causing the tube to burst if high currents occur, or blowout of the link from smaller current, delaying separation of arcing terminals so that the fuse tube will be burned. To overcome this, General Electric Co. engineers advise blocking the ends of the fuse tubes with wads of fluffy inorganic material such as rock-wool or glass-wool. Cut off ¾ in. sections of the small packing tubes which protect fuse links during shipment and load these sections with the material. By holding a loaded cylinder to the end of the fuse tube, the wad can be easily ejected into the tube by a pencil or wire so that insects cannot gain entrance. Tests have shown that, if not more than ¾ in. length is used, successful operation of cutouts will not be affected.

Factory Fuel Consumption

IN THE UNITED STATES Census Report for 1939, recently released in preliminary form, the manufacturing industries of the country, including the printing and publishing industres, reported a material reduction in the consumption of coal and coke, a slight increase in the consumption of fuel oil, and a large increase in gas consumption during the census year 1939 as compared with 1929, but decreases in all four classes of fuel from 1937.

The 1939 consumption of bituminous and anthracite coal combined totaled 142,787,289 short tons, a decrease of 63,444,734 short tons from 1929, or 30.8 per cent. A continually decreasing consumption of anthracite coal in manufacturing plants has been recorded since 1919. For 1919 the consumption of anthracite coal was reported as 13,735,918 short tons; 9,452,190 short tons in 1929; 6,561,820 short tons in 1937; and 5,015,857 short tons in 1939. Consumption of bituminous coal by manufacturing establishments rose from 188,233,036 short tons in 1919 to 196,779,833 short tons in 1929, but decreased to 162,960,976 short tons in 1937, and to 137,771,432 short tons in 1939.

Coke consumption of 35,115,357 short tons was reported for 1939, as against 50,917,737 short tons for 1929, and 42,194,064 short tons for 1937, or a decrease of 31 per cent and 16.8 per cent, respectively.

Fuel oil consumption increased slightly during the decade as a whole, the 1939 consumption of 133,773,524 barrels being 2,861,451 barrels, or 2.2 per cent, over 1929, but since 1937 oil consumption decreased by 2,490,520 barrels.

Gas consumption reported in 1939 was materially over that of 1929, but was substantially under that reported in 1937. Gas consumption, including both natural and manufactured gas, totaled 2,195,094,255 thousand cubic feet during 1939, an increase of 617,814,946 thousand cubic feet, or 39.2 per cent over 1929, but was 293,887,453 thousand cubic feet under 1937. Of the 1939 gas consumption, 881,830,178 thousand cubic feet, or 40.2 per cent, are reported as natural gas; 1,288,727,385 thousand cubic feet, or

...Short-Changed BY A BOILER?

Making steam is a business transaction. You pay a certain sum for fuel and water, from which you expect to get a proportionate amount of steam. In a deal like this, it is all too easy to receive short change.

Scale on a boiler's heating surface causes a direct drop in heat transfer with corresponding loss of efficiency and fuel. As little as one-sixteenth inch of scale may cause a loss of as much as thirteen per cent in heat units paid for, but not received.

Boilers using Bird-Archer treatments, administered accurately for the individual water and operating conditions, are not defrauded by scale. There is no heat loss from this cause and nobody gets short changed.

Have you a copy of this useful handbook on types of water, situations, treatments? We'll be glad to send you one—without cost, of course. Simply write for "Boiler Water Treatment."

THE BIRD-ARCHER CO.

Scientific Boiler Water Treatments
SINCE 1885

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SAFE on High Pressures!
Unbreakable MICASIGHT
Boiler Gage Inserts Stop Grief and Expense of Replacements

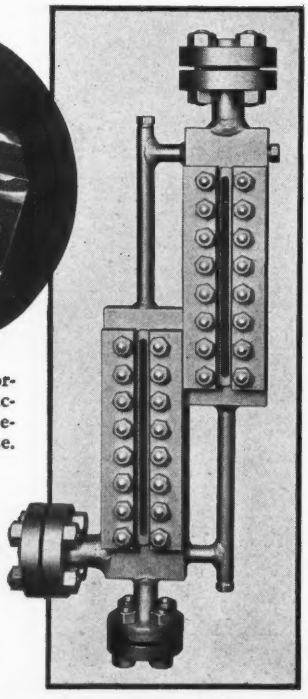
● Save constant upkeep expense and costly damage claims caused by breakage of boiler gage glass that can't stand high pressure punishment. The MICASIGHT Gage Insert is built to handle heaviest loads—can't shatter or blow.

Carefully selected sheets of mica clamped securely in heavy steel body, withstand highest pressures. Leakproof, gives clear visibility; can be illuminated for bright sharp reading high on the boiler. Can be scheduled for maintenance same as any mechanical equipment.

Hundreds of MICASIGHTS in use. Add this assurance of safety and uninterrupted power. Write for MICASIGHT Bulletin and prices, *now!*

THE RELIANCE GAUGE COLUMN CO.
5902 Carnegie Avenue • Cleveland, Ohio

Mica is not subject to corrosion, but is easily replaced in MICASIGHT if it becomes dirty after long use.



This special MICASIGHT is typical of those furnished for the *"tough jobs"*—test service on 1800 lb. pressure, prominent utility company boiler.

TRADE MARK - REG. IN U.S. PAT. OFF.
Reliance
Boiler Safety Devices since 1884

58.7 per cent, was manufactured gas; and 24,536,692 thousand cubic feet, or 1.1 per cent, was mixed (natural and manufactured). These data on the varjous classes of gas consumed must be taken with caution since the schedules indicate some confusion among reporting establishments as to the elements entering into the term "mixed gas," which classification includes a mixture only of natural gas and manufactured gas, and not a mixture of two or more classes of manufactured gas. No comparison with prior years is possible in the consumption of the three classes of gas as reported for 1939, as data on "mixed gas" was not called for in the 1929 or 1937 censuses.

Group Versus Individual Drives

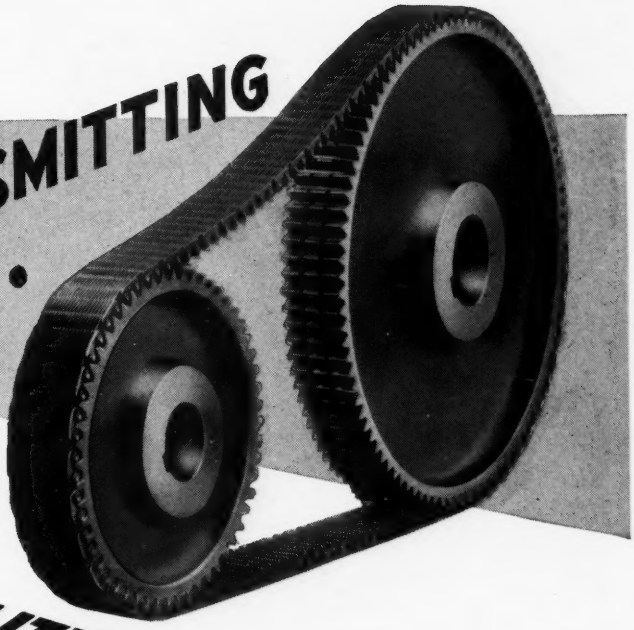
MECHANICAL power transmission between the motor or engine and the driven machine may be accomplished by means of one or more of several types of drive. Among these are belting, chains, pulleys, shafting and gears, each one of which offers to the engineer a variety of choices in type and design, and it would be unwise to offer a general solution covering all drives of a particular kind of a machine, each installation must be considered separately. Present day practice, however, is tending toward what is known as Modern Group Drives, consisting of comparatively small groups of machines which will operate together in contrast to individual drives where the machines are driven by individual motors.

To aid those faced with the problem of choosing between a modern group drive and an individual drive, J. E. Rhoads & Sons have listed the outstanding advantages of each of these types of drives, as follows:

Advantages of Modern Group Drives.

1. Lower motor costs. Large motors cost less per hp. A 1750 r.p.m. 20 hp. motor costs about $8.25 per hp. and a similar 1 hp. motor costs $37.00 per hp.
2. Lower installed horsepower. A Modern Group Drive requires a motor capacity close to the average load; while individual drives need sufficient motor capacity for the peak loads of each machine.
3. Lower control costs. Controls cost less per horsepower in large sizes and fewer are required in a group drive than in individual drives.
4. Lower wiring costs. Average wiring cost for a 20 hp. motor is $7.95 per hp. and on a 1 hp. motor $38.00.
5. Lower total installation costs are invariably possible except in some cases of extremely complex control requirements. Motor and wiring costs are not only less but frequently the mechanical drive cost is less also.
6. Lower fixed charges because of smaller investment and lower depreciation costs.
7. Lower power consumption is obtainable due to the higher electrical efficiency and higher power factor of large motors operating at more nearly full load.
8. Lower maintenance costs are almost directly proportional to the number of items to be maintained, and Modern Group Drive has fewer items to maintain than do individual drives.
9. Higher production. While machines can be designed to give any desired degree of produc-

IN POWER TRANSMITTING CAPACITY . . .



THIS GOOD LITTLE DRIVE BEATS A GOOD BIG DRIVE

MORSE High Speed Superdrives employ a recently developed and thoroughly tested principle to achieve their many advantages. With the same motor r.p.m.'s Morse Superdrives use larger sprockets with more teeth to get higher chain speeds—speeds up to a mile-a-minute and more!

At these high speeds, centrifugal force goes to work as Superdrives' helper, spreading the stresses so thin over chain and sprocket teeth that wear is reduced to a minimum. Power flows swiftly, smoothly, silently, and surely along the speeding chain, with power transmitting capacity actually rising faster than the speed of the chain.

Morse High Speed Superdrives offer great advantages—in the many applications to which it is suited—in long life, increased power transmitting capacity, strength, space economy, and dependability. Learn what they can bring to *your* high speed drives. Ask the Morse man near you, or write direct to Morse Chain Company, Ithaca.

SAME POWER FROM A DRIVE 1/3 THE WIDTH

Since power transmitting capacities are far greater in Morse Superdrives than in conventional drives, because of the greater chain speeds, Superdrives are narrower, more compact. For example: On a recently designed drive Morse specified 1″ pitch, 4″ wide chain to operate at 5100 feet per minute. Conventional design would have taken 1″ pitch, 12″ wide for the same capacity, the same motor speed, but with smaller sprockets and lower chain speed.

HIGH SPEED SUPERDRIVE

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP

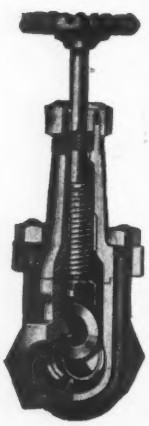
A U-bolt firmly locks together the body and bonnet of Fairbanks U-Bolt Gate Valve, making a pressure-tight joint and adding strength to the body. By removing only two nuts the valve can be easily and quickly taken apart for inspection or cleaning.

To prevent freezing or clogging above bonnet threads and permit draining back into body, it has relief slots in bonnet bushing.

To insure a tight seat and permit repacking under pressure without leakage, seat is above stem threads. This also prevents sediment reaching and scoring seating surfaces.

The heavy rolled-bronze stem has more than five full-cut Acme threads always in contact with bonnet. Body and bonnet are made of high-test iron with an average strength of 40,000 lbs. per sq. in.

Double-taper wedge, with knife edge, cuts through heavy fluids and sediment.



These are but a few of the advantages of U-Bolt Valve 0417. Made for 150 lbs. steam, 225 lbs. gas and liquid pressures, in sizes ½" to 4". Sold by distributors everywhere. Write for booklet No. 30.

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399 Lafayette St. New York, N. Y.
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Factories:
Binghamton, N. Y. Rome, Ga.

FAIRBANKS
U-BOLT GATE VALVES

tion, individually driven machines slow down at peak load. In group drives, the peak loads offset each other permitting higher uniform speeds.

Advantages of Individual Drives.

1. Machines which are remote from others can be operated efficiently. Some machines may be in such a position that individual drives are more economical.
2. In some departments of a few industries, machines need to be moved so frequently that it is advisable to have multiple outlet wiring. If the regular wiring is used, machines equipped with individual drives are neither less expensive nor quicker to relocate than machines in a Modern Group Drive equipped with steel stringer construction.
3. Material handling may be so complex that a line shaft cannot be placed in any position without interfering with the necessary movement of goods.
4. A comparatively large machine which is run intermittently can probably be operated more economically if individually driven.

Alloys of Today

WITH INCREASED production demanded throughout industry, the strong trend towards the wider uses of existing alloys and the development of new materials is now gaining tremendous strength. Reports made public by The International Nickel Co., Inc., show that all alloys, ferrous and non-ferrous, are involved.

Nickel-copper alloy steels, for instance, sponsored as proprietary products by many steel makers, are rapidly extending their markets in the transportation field, and are finding extensive use for drill pipe and other petroleum applications. They have greater corrosion resistance and better fatigue properties than the materials they are replacing.

Excellent welding qualities as well as toughness at sub-zero temperature are factors augmenting the use of low carbon nickel alloy steels, particularly for low temperature service.

Increased interest is manifest in steels containing 3½ to 5 per cent nickel in the chemical and process industries. A case in point is the large quantities of 5 per cent nickel steel tubing which have been installed in black liquor evaporators in paper mills.

For High Pressure and High Temperature

Stainless steels of the 18 and 8 higher alloy type, widely used in high pressure, high temperature boiler and piping construction, are undergoing a marked increase in tonnage. These corrosion resistant metals also are being increasingly used not only in streamlined trains but in truck construction, since they cut dead-weight and thus provide higher pay load capacities.

With more than 10 yr. experience behind them in the production of alloyed cast irons, foundrymen have made marked progress in large volume production. Increased knowledge and improved technique in the production of these irons have enabled the foundrymen not only to develop high standards of quality, but have also enabled them to meet increasingly more rigid specifications. Thus, the manufacturer of high quality equipment is able to depend on thoroughly reliable sources for castings to meet

"V" IS FOR VICTORY

DOUBLE "V" OR "W" IS FOR WARREN

scoring a double victory with
BOILER FEED PUMPS
of both Reciprocating and Centrifugal types . . .

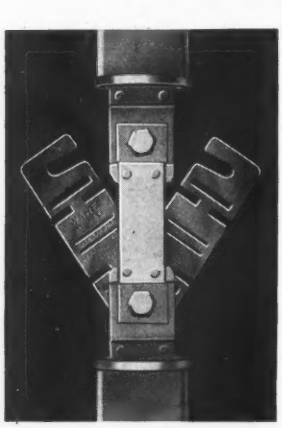
Thousands of successful installations, over a long period of years, eliminate any question as to reliability, efficiency and low maintenance cost, regardless of which type Warren Pump you select. Our Engineering Department will be glad to make recommendations, taking into consideration your particular conditions and needs. Write for new, comprehensive bulletins today, covering *both* Reciprocating and Centrifugal types for Boiler Feed Service.

WARREN STEAM PUMP COMPANY, Inc.
WARREN, MASSACHUSETTS

100% PROTECTION
at MINIMUM COST

Although the purpose of a fuse in an electrical circuit is to introduce a "weak link" where its rupture will do the least harm, WARE engineers have succeeded in bolstering this "weak link" thus eliminating **needless** blows and production delays.

They have built into WARE HI-LAG Fuses a **high time lag** which enables these fuses to absorb momentary surges. The WARE Patented design also provides the **double-bridge**, self-aligned knife blade assembly which gives added strength. It also utilizes larger surfaced spring tension contacts which helps prevent blows due to faulty contacts.



Decide now to cut down on fuse maintenance and save many needless production delays by fitting all circuits with WARE HI-LAG Renewable Fuses.

WARE BROTHERS
4500 W. Lake St., Chicago

APPROVED BY UNDERWRITERS

Write for TRIAL TEST OFFER, SIZES and PRICES.

WARE
Renewable
HI-LAG FUSES

his needs. The builders of machine tools offer outstanding examples.

Among the bronzes, superior materials at reasonable cost have been developed for special applications with mixtures containing from 5 to 15 per cent nickel. Some of these alloys in the "as cast" condition, show a strength of 45,000 to 48,000 lb., which, upon heat treating, can be brought up to 75,000 to 80,000 lb. per sq. in. Bronzes of this type are not subject to changes in structure or composition under outdoor exposure, and are useful for highly stressed members of transmission line switch gear and conductor wire supports. The high strength and dense structure of these alloys promise long life for wearing parts. In many fields non-ferrous foundrymen are increasing their use of nickel for production of pressure tight brass and bronze castings.

Another alloy whose use is expanding, especially in the marine field, is 70-30 copper-nickel. Besides condenser tubes, where its economy has been established over lower priced compositions, this alloy is being adopted for pipe lines handling sea water for flushing, fire and sanitary services, drain pipes, valves and fittings for salt water lines.

In the extension of air conditioning, there is a broadening of markets for thermostatic bi-metals used to control temperature. These controls make use of nickel-iron alloys containing 36 to 45 per cent for the low expansion side, and 20 to 70 per cent nickel for the high expansion side.

Corrosion Resistant Alloys

Two important corrosion resistant alloys in the higher nickel alloy group, previously available only in cast forms, are now being produced in wrought form as well. These alloys are Hastelloy C and Illium.

Of outstanding importance in the family of nickel and nickel alloys are the group usually associated with rolled nickel. These include among others Monel, Inconel, "K" Monel and "Z" Nickel. Primarily used to defeat corrosion and to preserve product purity in many industries, rolled nickel and Monel have served a wide range of requirements for over 30 yr. They have been recognized as special duty materials. The first step towards a further specialization came about 10 yr. ago with the introduction of Inconel—containing approximately 80 per cent nickel, 14 per cent chromium, and 6 per cent iron.

Since the introduction of Inconel additional steps in the production of specialized alloys have come with "K" Monel and "Z" Nickel. Both are heat treatable to provide strength and hardness usually associated only with some of the heat treatable alloy steels.

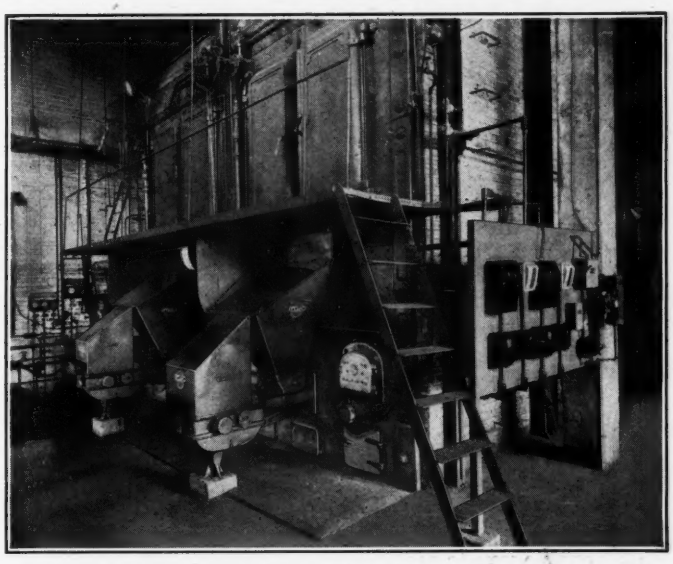
Applications of "K" Monel for heavy duty pump shafts and other items of equipment where high resistance to corrosion must be combined with strength and exceptional wear resistance, are mounting significantly. "Z" Nickel, whose mechanical properties run even higher than those of "K" Monel, is expanding in use for electrical applications and for spring purposes, where its unusual fatigue resistance is a big factor.

As the demand for special duty materials grows more urgent, some of the casting alloys are coming more and more to the fore—led by "S" Monel. Non-galling and highly resistant to wear, it is forging ahead as an important material for valves, valve trim, liners, and similar purposes.

"SAVED OVER 30% IN FUEL COST even though our load has increased!"

*"You can't buy back these Stokers for **Twice** the price I paid for them."*

says George Norton, of Norton & Company.



View shows two CANTON Vulcan Ramfeed Stokers installed at Norton & Co. under 200 H.P.-HRT Boilers with capacity of 200% of Boiler rating. The Synchronized Combustion Control is centralized on Panel Board at extreme right.

WHEN George Norton looked around for the one BEST Stoker for his plant in a Washington, D. C., suburb, it wasn't a question of politics, price or prestige — he wanted the highest return per dollar invested!

Faith in CANTON'S facilities and 31 years' experience in this field, led him to purchase two CANTON Vulcan Industrial Ramfeed-Side Dumping Stokers, equipped with Fluid-Power Synchronized Combustion Control.

The results are typical.

Whether your plant is hand-fired or equipped with a less modern Stoker, you can profit also by looking into CANTON'S complete line of Stokers and Synchronized Combustion Control. It is the ONLY Stoker guaranteed for FIVE YEARS against not only defects—but even Wear!

CANTON STOKER

Write Today for Free Descriptive Bulletins

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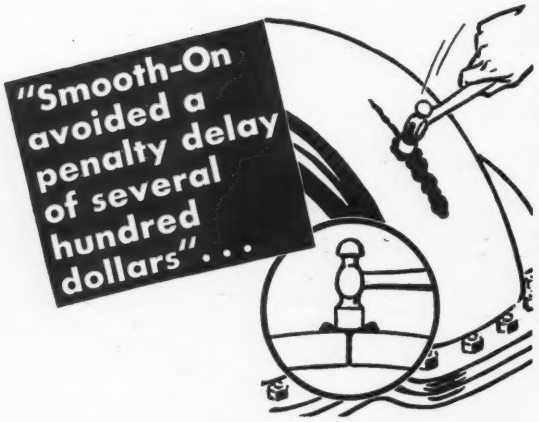
900 ANDREW PLACE, S.W., CANTON, OHIO



. . . now, we always keep Smooth-On for emergencies

During the test of a centrifugal pump, the casing cracked. Time was valuable, because delay would have involved a penalty. The engineers filled the crack with Smooth-On No. 1, and a day later the tests were resumed. The test was completed successfully. The operating engineer reports that throughout the following five years during which he remained at the plant, the pump was in steady service and the repair continuously tight.

Many other speedy, low-cost repairs

Wherever a crack or leak develops in an apparatus shell or casing or at a joint or connection of any kind, Smooth-On will enable you to make the repair easier and at less cost than by any other method. No dismantling of parts, no heat, and no special tools are required, and the repair is lasting. For helpful suggestions as to the many money-saving applications of Smooth-On, write for the free Smooth-On Handbook.

FREE 40-PAGE HANDBOOK
if you send us your name and address on a post card

Get Smooth-On No. 1 in 7-oz., 1-lb. or 5-lb. can, or in 25-lb. or 100-lb. keg from your dealer, or if necessary from us.

For your protection, insist on SMOOTH-ON, used by engineers and repair men since 1885.

Every engineer should have this valuable handbook which contains many ingenious, practical repair guides not to be found in any other publication. Be sure to write today for your free copy.

Smooth-On Mfg. Co., Dept. 31
570 Communipaw Ave., Jersey City, N. J.

***Do it with* SMOOTH-ON**
The iron repair cement of 1000 uses

Hydro Power For National Defense

AS A BULWARK to national security, Roger B. McWhorter, Chief Engineer of the Federal Power Commission, speaking before the Midwest Power Conference, commended for consideration the development of additional feasible water-power resources. Stating that more than one-fourth of the available electric generating capacity of the country is in hydroelectric equipment and that from one-third to two-fifths of all electric energy generated for public use comes from this inexhaustible source, he considers water power of prime importance to national economy. Specific uses to which hydroelectric power is now being put in aid of national defense were enumerated as follows:

Hydroelectric energy generated at Niagara Falls is supplied, either directly or in combination with steam-electric energy, to numerous industries which manufacture products essential to the national defense program. Such products included aluminum and steel for aircraft manufacture and general construction; ferro alloys for the production of high-alloy steels; artificial abrasives for cutting and grinding; carbon and graphite electrodes for electric-furnace operation; calcium carbide, from which acetylene gas is derived; chlorine, for water treatment, bleaching, and other purposes; freight cars for the expanding railroad traffic; airplanes for the Army and Navy, and for commercial use; and wire and cable for electrical machinery and appliance.

The Tennessee Valley Authority supplies hydro power, either directly or indirectly, to numerous industrial establishments, large and small, the products of which are of value in the national defense program. Power in very large quantity is now being supplied from the T.V.A. system to the Aluminum Company of America for the manufacture of aluminum, and contracts have been signed for supplying large blocks of power to another company which will be engaged in the reduction of bauxite and the manufacture of aluminum. Practically all of this aluminum is to be used for national defense purposes.

Bonneville hydro power will be used extensively by national defense industries, two large companies having contracted for 222,500-kw. to be used in the manufacture of aluminum. It is reported also that other industries have entered into contracts, or are negotiating contracts, for Bonneville power to be used for the manufacture of products having national defense value.

The output of the 100,000-kw. Hawks Nest plant on New River, W. Va.; is used exclusively for the manufacture of products of special significance in the national defense program, and much of the output of the Santee-Cooper project will be used for national defense purposes.

New England is the scene of unusual industrial activity, due in large part to the national defense program. Nearly all of the electric energy required in the State of Maine is generated in hydroelectric plants within that State, and a substantial part of the energy requirements of other New England States comes from hydro plants on the Connecticut and Deerfield Rivers.

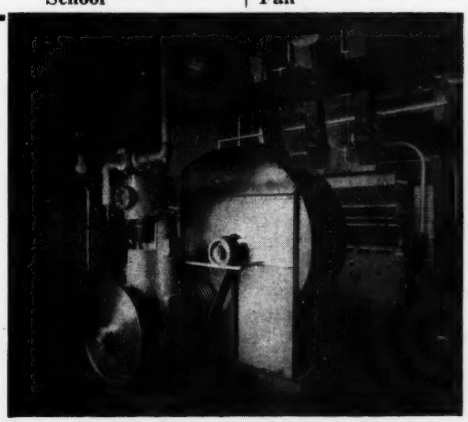
PLENTY OF PROOF... that..

TROY-ENGBERG STEAM ENGINES

reduce power costs to a marked degree by making steam do double duty

During the latter part of 1940, we conducted a survey on steam engine power costs in a number of plants similar to the survey conducted about four years ago. Below are tabulated some of the more recent results, providing plenty of proof that Troy-Engberg Steam Engines can bring about great reductions in power costs.

Type of Plant	Driven Machine	Power Cost at Shaft of Driven Machine —¢ per Kw.-Hour Motor	Engine	Engine Power is—% Cheaper	Annual Return on Installed Engine Cost	Savings Will Pay for installed Engine Cost in—Months
Dairy	Ammonia Compressor	1.36	0.3	78%	144%	9
Soap Factory	Rolls	0.997	0.63	37%	19%	48
Utility	Gas Exhauster	2.15	0.69	68%	152%	8
Smelter	Forced Draft Fan	2.2	0.604	72%	74%	17
Waterworks	Centrifugal Pump	No motor data available	0.29	....	....	..
Oil Refinery	Rotary Pump	0.84	0.485	42%	50%	24
Hospital	Stokers	1.4	0.322	77%	74%	6
Chemical Plant	Blower	1.52	0.06	96%	360%	4
Paper Mill	Stokers	1.43	0.47	67%	50%	24
School	Fan	4.65	0.284	93%	284%	5



Steam should be made to do double duty and if conditions are right, the steam engine, while providing excellent drive characteristics for equipment such as illustrated, greatly reduces power costs.

We suggest that you investigate the use of Troy-Engberg Steam Engines for your plant.

TROY ENGINE & MACHINE CO.

Established 1870

838 RAILROAD AVE., TROY, PA.

9-TEM-1

Power Plant Construction News

Calif., Inglewood—North American Aviation, Inc., Inglewood, will install electric power equipment in connection with plant expansion for production of aircraft for Government. Cost estimated at $795,300, with majority of fund to be used for purchase of machinery and equipment. Appropriation in amount noted will be secured through Defense Plant Corporation, Washington, D. C., a Federal agency, for project.

D. C., Washington—Bureau of Yards and Docks, Navy Department, Washington, plans two mobile electric power plant units, railway mounted. Cost estimated at $2,500,000. Fund in that amount is being arranged in supplemental appropriation bill for purchase of equipment and construction.

Fla., Pensacola—Gulf Power Co., Pensacola, plans new steam-electric generating station on local site, with initial installation to include a 20,000-kw. turbine-generator unit, high-pressure boiler and auxiliary equipment. Company is arranging for sale of bond issue to total about $3,600,000, with large part of this fund to be used for new plant, transmission and distributing lines.

Ga., Brunswick — Georgia Power Co., Atlanta, Ga., plans expansion in steam-electric generating station at Brunswick, with installation of additional equipment for increased capacity. Also, will make extensions in transmission lines in Brunswick area. No estimate of cost has been announced.

Ind., Evansville—Southern Indiana Gas & Electric Co., 20 N. W. Fourth Street, has approved plans for addition to local steam-electric generating station, for which superstructure will soon begin. Additional equipment will be installed for increased capacity. No estimate of cost has been announced.

Iowa, Durant—City Council has plans under way for new municipal power plant, estimated to cost about $115,000. Project was approved at recent special election. Proposed to use Diesel engine-generator units and accessories.

La., Alexandria—Utilities and Finance Department, W. A. McLean, commissioner, plans expansion and improvements in municipal steam-electric power plant, with installation of additional equipment for increased capacity. Cost estimated about $275,000. Financing will be arranged soon.

Me., Portland—Cumberland County Power & Light Co., 443 Congress Street, has preliminary plans under way for addition to local steam-electric generating station on Knightville Street, with installation of additional equipment for increased capacity. Work will include extensions in transmission and distribution lines, and a new power substation on Highland Avenue. Estimates of cost are being made.

Md., Baltimore — American Hammered Piston Ring Division of Koppers Co., Bush and Hamburg Streets, manufacturer of piston rings and kindred products, plans installation of electric power equipment in new plant on local site for production of aircraft engine parts for Government, comprising several one-story buildings. A steam power house is planned. Entire project will cost about $1,250,000, of which approximately $900,000 will be expended for machinery and equipment. Fund in amount noted will be furnished by Defense Plant Corporation, Washington, D. C., a Federal agency, for project.

Mich., Detroit—Fisher Body Division, General Motors Corp., General Motors Building, Detroit, plans installation of electric power equipment in local plant and in branch works at Muncie, Ind., in connection with expansion for production of aircraft parts for Government. Entire project will cost about $894,000, and appropriation in that amount will be furnished by Defense Plant Corporation, Washington, D. C., a Federal agency, for project. Work is scheduled to begin at once.

ADSCO-BANNON CONDUIT
TILE CONDUIT FOR UNDERGROUND LINES

(Below) Insulated steam lines in place and ready for top of conduit and backfilling.

(Above) Bottom half of conduit and base drain with pipe supports and saddle plates ready for steam pipe installation.

(Below) Completed conduit installation ready for backfilling operation.

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ADSCO-Bannon Tile Conduit for underground steam and hot water lines is a strong, vitrified product available with or without base drain in sizes from 4-24″ inclusive. In combination with ADSCO Filler Insulation—a "Fiberglas" product, it is very reasonable in cost, easily installed with a minimum of field engineering and makes a permanent installation of high thermal efficiency. Most orders can be shipped promptly from ample stocks or shortly after receipt of order at the tile factory.

Send details of installation for quotation or write for Bulletin No. 35-67 E.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

Miss., Flora—General Tire & Rubber Co., Akron, Ohio, through its subsidiary, General Tire Engineering Co., Jackson, Miss., will install electric power equipment in new ammunition bag-loading plant near Flora, vicinity of Canton, where tract of 65 acres of land has been acquired, to be used for production for War Department, Washington, D. C. Also plans steam power house, electric power substation, pumping station, etc. Entire project will cost about $11,970,000 and fund in that amount will be furnished by Defense Plant Corporation, Washington, D. C., a Federal agency, for project.

Miss., Hattiesburg — Mississippi Power Co., Gulfport, Miss., has plans under way for new steam-electric generating station at Hattiesburg, with initial capacity of 20,000-kw. Also will make extensions in transmission lines in that area, with power substations, switching stations and other facilities. Company is arranging for bond issue in amount of $3,250,000, a considerable part of proceeds to be used for purpose noted.

N. Y., Tonawanda—Chevrolet Motor & Axle Division, General Motors Corporation, River Road, plans installation of electric power equipment in new one-story addition, totaling about 250,000 sq. ft. of floor space, to be used as a testing shop for aircraft engines. Cost estimated close to $750,000. Company is now converting local plant for the production of airplane engines and parts for Government.

Ohio, Cleveland—Euclid Road Machinery Co., 1361 Chardon Road, is completing plans for new power house for service at plant, with installation to include two boiler units, stokers, pumps and auxiliary equipment. Cost reported about $45,000, with equipment. H. M. Morse Co., 1500 Superior Avenue, is architect; Mayer & Valentine, Plymouth Building, are consulting engineers.

Ohio, Toledo—Toledo Edison Co., Edison Building, is said to be planning expansion in local steam-electric generating station, with installation of additional equipment for large increase in present capacity. Cost reported over $5,000,000.

Okla., Lawton—Western Electric Co-operative, Inc., Cyril, Okla., has plans maturing for new steam-electric generating plant in vicinity of Lawton (Comanche County), for power supply to a group of nine rural electric line cooperative organizations in that district. An initial fund of $500,000 has been secured through Federal aid to begin work on project, which is estimated to have ultimate cost of more than $4,000,000, including transmission lines, power substations and other facilities.

Texas, Austin—City Council, Guiton Morgan, city manager, plans expansion and improvements in municipal power plant and electrical distribution system, including new power substations, lines, station equipment, service connections and facilities. Also, extensions and improvements in water system, with installation of new pumping machinery and other equipment. Entire project will be carried out over a period of about 24 mo., and is estimated to cost close to $960,000.

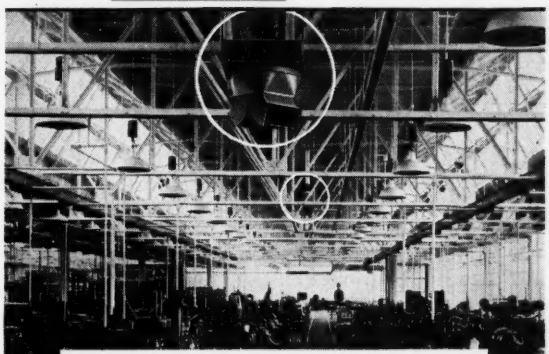
Texas, Borger—Panhandle Light & Power Co., is considering construction of new steam-electric generating station, with initial installation to include a 20,000-kw. turbine-generator, high-pressure boiler and auxiliary equipment. Entire project is reported to cost over $1,500,000, with extensions in transmission lines, power substations and other facilities.

Texas, Dallas—Dallas Power & Light Co., 1506 Commerce Street, has plans under way for expansion in Mountain Creek steam-electric generating plant, including installation of new 25,000-kw. turbine-generator unit and accessories, boiler and auxiliary equipment. Cost estimated close to $2,500,000.

Va., Alexandria — Virginia Public Service Co., Alexandria, is arranging a tentative budget of about $4,000,000 for expansion and improvements in power plants and system during coming year, including transmission and distributing lines, power substations and other operating facilities.

Wash., Seattle — Isaacson Iron Works, Inc., 2917 East Marginal Way, plans installation of electric power equipment in new plant on four-acre tract of land on Duwamish Waterway, for production of heavy steel forgings for Government. It will consist of several large one-story units. A boiler house is planned. Entire project will cost about $2,600,000. Appropriation in that amount will be provided by Defense Plant Corporation, Washington, D. C., a Federal agency.

WING REVOLVING UNIT HEATERS



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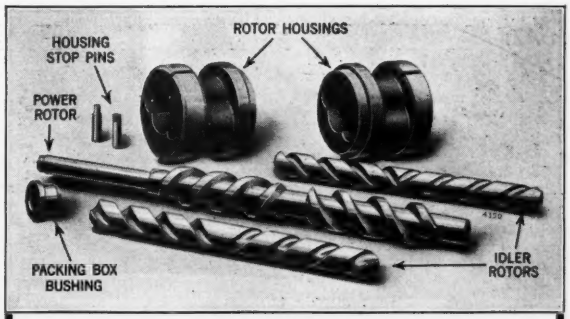

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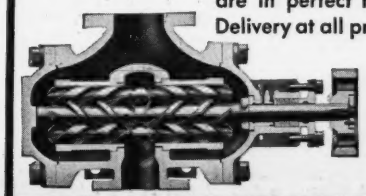

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IMO PUMP DIVISION

of the De Laval Steam Turbine Co., Trenton, N. J.

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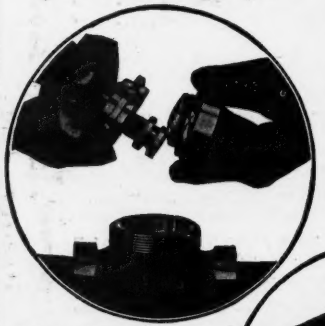
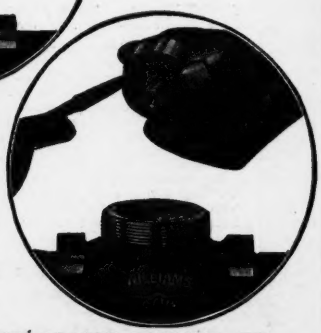


In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



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